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THE POPULAR SCIENCE MONTHLY.

CONDUCTED BY E. L. AND W. J. YOUMANS.

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THIRTY-SIXTH ANNUAL STATEMENT

OF THE

CONNECTICUT MUTUAL

LIFE INSURANCE COMPANY

OF HARTFORD, CONN.

NET ASSETS, January 1, 1881		$47,833,628.70
RECEIVED IN 1881.		
For Premiums	$5,238,811.82	
For Interest and Rents	2,839,328.08	
Profit and Loss	91,626.11	8,160,766.01
		$55,994,394.71

DISBURSED IN 1881.

TO POLICY-HOLDERS:		
For claims by death and matured endowments	$3,718,646.87	
Surplus returned to Policy-holders	1,284,342.53	
Lapsed and surrendered Policies	1,081,234.81	
TOTAL TO POLICY-HOLDERS	$6,084,224.21	
EXPENSES:		
Commissions to Agents	$286,797.05	
Salaries of Officers, Clerks, and all others employed on salary	103,541.93	
Medical Examiners' fees	10,540.25	
Printing, Advertising, Legal, Real Estate, and all other Expenses	276,607.84	
	$677,487.07	
TAXES	454,590.06	
		$7,216,301.34
BALANCE NET ASSETS, December 31, 1881		$48,778,093.37

SCHEDULE OF ASSETS.

Loans upon Real Estate, first lien		$18,037,201.15
Loans upon Stocks and Bonds		401,303.28
Premium notes on Policies in force		3,347,600.47
Cost of Real Estate owned by the Company		12,657,974.92
Cost of United States Registered Bonds		4,618,853.10
Cost of State Bonds		619,9 0.00
Cost of City Bonds		2,572,300.84
Cost of other Bonds		3,407,480.00
Cost of Bank Stock		122,761.00
Cost of Railroad Stock		26,000.00
Cash in Bank		2,933,319.50
Balance due from Agents, secured		33,399.14
		$48,778,093.37
ADD		
Interest due and accrued	$925,583.50	
Rents accrued	14,373.88	
Market value of stocks and bonds over cost	497,676.62	
Net premiums in course of collection	NONE.	
Net deferred quarterly and semi-annual premiums	43,058.08	
		$1,480,691.18
GROSS ASSETS, December 31, 1881		$50,258,784.85
LIABILITIES:		
Amount required to reinsure all outstanding policies, net assuming 4 per cent. interest	$45,810,598.00	
All other liabilities	1,060,614.87	
		46,871,212 87
SURPLUS by Connecticut Standard, 4 per cent		$3,387,571.98
SURPLUS by New York Standard, 4½ per cent., about		6,500,000.00
Ratio of expense of management to receipts in 1881		8.30 per cent.
Policies in force December 31, 1881, 63,913, insuring		$159,039,867.89

JACOB L. GREENE, President.

JOHN M. TAYLOR, Secretary. W. G. ABBOT, Ass't Secretary. D. H. WELLS, Actuary.

PHILIP S. MILLER,

GENERAL AGENT FOR N. Y. CITY, LONG ISLAND, AND NEW JERSEY, 1 WALL STREET, CORNER OF BROADWAY, NEW YORK CITY.

THE

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93.

PROFESSOR LOUIS PASTEUR.

THE

POPULAR SCIENCE MONTHLY.

APRIL, 1882.

CHINESE IMMIGRATION: A SOCIOLOGICAL STUDY.

By GERRIT L. LANSING.

TO any one who has thought about the Chinese, the contrast presented by a comparison of their civilization with the civilization of the Western nations must have given rise to frequent speculation as to the cause of so great a difference. Should we be brought into communication with another planet, we could hardly expect to find a people more unlike us than the inhabitants of China. They have existed substantially as at present from a time long before a single language existed which is spoken to-day in Europe, and even before our classic dead languages were born. While the tribes, nations, and civilizations of the West have come and gone, the Chinese have remained the same, generation after generation and century after century, content always to live and die in the conditions that Fate has imposed upon them in the Middle Kingdom. A century and a half ago Du Halde wrote of their incurable conservatism, "that they have continued the same with regard to the attire, morals, laws, customs, and manners, without deviating in the least from the wise institutions of their ancient legislators."* And in our time we are told by the Abbé Huc—than whom no one has had better opportunities from which to judge—that "they seem to have been always living in the same stage of advancement as in the present day."† Peaceful occupations, untiring industry, and a careful frugality have characterized the habits of the people in the past as they do in the present. Wars were never justified except to secure peace, and upon the cessation of hostilities the armies eagerly returned to their peaceful pursuits.

The Western nations present a different picture. Our Aryan an-

* "History of China," vol. i, p. 237, folio edition, London, 1738.

† "Chinese Empire," vol. ii, p. 255, London, 1855.

cestors, wandering with their herds over the plains of Central Asia, encouraged, by the habits and necessities of their lives, that liberty of action and individual freedom which have characterized those of their descendants who by their emigrations have peopled Europe and America. It seems more than probable, also, that this spirit has been strengthened by the natural selection of those individuals as emigrants in whom the feelings of discontent and curiosity were associated with a temperament that neither hesitated through fear nor turned back from obstacles. These it was who braved and triumphed over the natural hardships of an unbroken wilderness and the not less fearful supernatural obstacles which occupy all unknown countries in the minds of uncivilized man. Century after century were these hardy and indomitable characters strengthened by use and transmitted by inheritance. Whether we consider the ancient civilized nations, the rude Germanic tribes, or their modern descendants, illustrations will everywhere be presented of the universal tendency to independence and change among all the Indo-European peoples. We are told by Heeren, in the "Political History of Ancient Greece,"* that, "while Asia, during all the changes in its extensive empires, shows only the continued reproduction of despotism, it was in Europe that the germ of political freedom unfolded itself, and, under the most various forms, in so many parts of the same soil, bore the noblest fruits, which again were transplanted thence to other parts of the world." Similar testimony is borne by Hume to the character of the uncivilized tribes of the north of Europe.† "The government of the Germans," he says, "and that of all the northern nations who established themselves on the ruins of Rome, was always extremely free. . . . The free constitutions then established, however impaired by the encroachments of succeeding princes, still preserve an air of independence and legal administration which distinguish the European nations; and, if that part of the globe maintains sentiments of liberty, honor, equity, and valor superior to the rest of mankind, it owes these advantages chiefly to the seeds implanted by those generous barbarians."

That the modern descendants of these ancient nations and tribes still possess the predominant characters of their ancestors, is sufficiently illustrated by the estimate given by Buckle of his own countrymen. "We, in England," he says, "are a critical, dissatisfied, and captious people, constantly complaining of our rulers, suspecting their schemes, discussing their measures in a hostile spirit, allowing very little power either to the church or to the crown, and managing our own affairs in our own way."‡ By the complete possession of these characters, the American people involuntarily acknowledge their English descent.

It is unnecessary to multiply examples; from the earliest history of our race to the present generation, similar impulses have prevailed

* Oxford, 1833, p. 1.

† "History of England," chap. iii, appendix.

‡ "History of Civilization in England," vol. ii, p. 29.

and have been followed by similar actions. Dissatisfaction with existing conditions has encouraged the spirit of rebellion; oppression has been followed by revolt; the employment of force in the support of injustice has been followed by force in the maintenance of justice. Everywhere appears the spirit of discontent with existing conditions, and constant effort for their improvement.

The difference in the characters of the Chinese and European peoples is older than their histories, as it is the same when their histories commence. It is fundamental, and as immutable as are the physical characteristics of the races—subject to but slight change in long periods of time. The Chinese are constant in their adherence to old-established customs and ideas. The genius of the Western nations is that of change and progress. As the Chinese mandarin confers honors by his rank upon his father, and the European transmits his titles to his son, so in all things the former receives his highest inspiration from the past, the latter from the future.

The cause of this contrast is that underlying the vital question of Chinese immigration; it exists in the different races of the people composing the different societies, and finds its explanation in the operation of the same laws which govern the evolution of all races and species of the animal kingdom.

Considering, then, the Chinese as a race, let us notice some of the laws of development of races and species, for they hold equally well with man as with other members of the animal kingdom. The transmission of race-characters by inheritance is not only strongly persistent and subject to but slight change in long periods of time, but also the development of certain characters is often continued long after they have passed the condition of usefulness. A character, which from selection may have become fixed in a species or race, may also continue in its development from the strengthening tendency of heredity as the race increases in age, and by the development from use of all those parts which give it nourishment.

In the classification of species or races, physical characters alone have usually been employed; but those mental traits which are made manifest in habits and customs, though less easy of observation, are equally constant, and therefore suitable.

The distinguishing characteristics of genera, species, race, or tribe, physical and mental alike, are constant in the order named. As their development is in an inverse order—as slight variation must precede great change and tribes develop before races, races before species, and species before genera—the degree of constancy in all is controlled by the general law that the *inheritance of characters is persistent in proportion to the length of time they have been inherited.* The characters which mark a species are more constant and uniform than those which distinguish races, tribes, or families.

If the Chinese are a different race from the nations of the West,

we may expect to find among them a different civilization, based upon different mental characters and temperament. If their customs, laws, and government have remained the same from a remote antiquity, we may expect to find them so persistent as to resist all effort at change; and we may find forms, which were anciently of great benefit, still transmitted by inheritance, though they may now have become injurious by interfering with the introduction of new forms of greater utility. These expectations, as will hereafter appear, are fully justified by the facts.

As nations are the necessary product of their parts—as the government is as it is because the people are as they are—it follows that a certain degree of homogeneity is necessary to secure peace and permanence. A majority of the people must have sentiments, instincts, and temperaments, as nearly similar as possible, where a difference in circumstances, occupations, and position is necessary. It is a constant strain upon the coherence of a nation, where the parts are of different civilizations. This would in fact be opposed to the very idea of a nation. As defined by Bagehot,* "a nation means a like body of men, because of that likeness capable of acting together, and because of that likeness inclined to obey similar rules." A nation may, like the United States, be composed of parts of various other nations, but they must be of a common race and civilization. The history of the Indians and the negroes in America too plainly demonstrates the truth that, where the races are different and the societies have different civilizations, rapid assimilation is impossible. As long as such a difference exists there will be a conflict, which can be ended only by the slow process of assimilation by variation of race, or by the extermination of the weaker. The permanence of national structure can be maintained only by the homogeneity of its civilization. "So long," says Spencer, "as the characters of the citizens remain unchanged, there can be no substantial change in the political organization which has slowly evolved from them."† Conversely, it follows that, upon the introduction of inharmonious foreign elements, the society must be proportionately modified. The introduction of the Chinese into our American society would be a union of different civilizations and different races. Each would stand by itself, from being too different to appreciate the other. They would be united only in the common interests of protection to life and property, and would defeat those primary objects by differing so fundamentally as to the method of their accomplishment. Very little assimilation could take place, and, by the law of heredity, the newer institutions would be the more readily changed, the older and more deeply rooted would be the more persistent. If the immigration should be so small—though there are reasons for believing it would not be—that the American population would always be in a large ma-

* "Physics and Politics," p. 21.

† "Study of Sociology," "Popular Science Monthly," vol. ii, p. 263.

jority, there would still result the establishment of a non-assimilable class, that would be looked upon as an inferior caste, and would be ruled without regard to their wishes or interests. Such a class, in a republican government, would be as much of an anomaly, and as impossible of permanence, as the institution of slavery.

That the evolution of societies is governed by the same general laws which govern the evolution of organisms might be assumed, *a priori*, from the fact that societies are but aggregates of organisms. So, a society itself may be considered as an organism, for its existence as an aggregate necessitates the homogeneity of the parts composing it. The people must be of the same race and civilization, and in their institutions, laws, and customs, represent those instincts and temperaments which are characteristic of their race.

In past ages, war has been the chief means by which different civilizations have been brought together. The customs of the conquerors have been forced upon the conquered, thus leading to the common belief that the force thus employed was the cause of the resulting change in the society. The fact that the conquering race or nation generally prevails by virtue of superior numbers—the most important element, perhaps, in the conquest of a civilization—gives further color to this interpretation. But the numerous instances in which the civilization of the conquered nation is that which has prevailed show that the conquest by armed forces has been followed by a conflict of civilization, in which the dominant form has been determined, not by success in arms, but by persistence of characters, and by the relative number and fitness of the contending societies. That hatred of strange peoples which formerly characterized the intercourse of nations, that was born in ignorance and nourished by wars, has been weakened also by the better knowledge of one another which the same conflicts have brought about. Where formerly was only the crossing of arms is now a growing friendly intercourse. Invasions by armies have been succeeded by peaceful immigrations ; but, though the conflict of arms may pass away, the peaceful mingling of nations and races will be followed still by the same conflict of civilizations. This is illustrated throughout the whole range of human history ; but it may be sufficient to briefly consider for this purpose two civilizations, which were represented by the most powerful monarchies of the Eastern and Western hemispheres, in which the conquerors in war became the conquered in peace, and in which the mingling of races resulted in the subversion of the higher civilizations. Such was the history of the Romans and the Mexicans.

The civilization of the Romans, to which the modern civilized nations are to so great an extent indebted, has naturally attracted the particular attention of scholars and philosophers. In attempting to account for the fall of that mighty structure, and the following period of ignorance and barbarism, there have been given nearly as many

reasons as there have been writers. Among the many causes that were more or less instrumental in producing this melancholy page of history, have been noticed the decay of religious faith ; the loss of the love of freedom, produced by a system which made half of the population slaves ; accumulation of wealth, and destruction of the middle class, the society consisting only of the very rich and the very poor ; disinclination to marriage of the Roman citizens, which became so general that the government was led to offer a premium for marriages ; and the decimation of the Roman youths by constant wars. In so complicated a problem, in which so many causes have led to the same result, it is necessary, in order to discover the primary and fundamental cause, to rise above those more transitory and local elements which confuse rather than aid the observer. So, if we look above all these, there will appear a further cause—the cause, indeed, of these causes—in the conflict of societies, of different races, or of different civilizations.

In the middle of the second century B. C., the arms of the Roman Republic encompassed the Mediterranean from Carthage to Cadiz ; the world obeyed the mandates and bowed to the authority of the Senate and the Roman people. The acquisition, however, of this great power and wealth became the cause of her subsequent weakness and poverty. The victorious arms of the legions were the plowshares which prepared the soil to receive the seed of final dissolution. Of the century following we read, that "the vast admixture of foreign elements produced boundless self-indulgence, and general faithlessness and corruption. New vices were imported, mainly from Greece and Asia, new creeds from all parts of the world." * Prisoners of war were retained as slaves by their conquerors, and to these so many had been added by purchase that, when it was proposed to discriminate the slaves by a peculiar habit, it was justly apprehended that there would be too much danger in acquainting them with their numbers. The slave population in the first century has been estimated to have been sixty million, "and at least equal in numbers to the free inhabitants of the Roman world." † These, by their services, aided the degeneration and hastened the mortality of their masters ; they became citizens, soldiers, senators, and emperors. The Romans themselves had become a fast-decreasing minority in their own empire. From the adoption of the luxurious customs of their Oriental provinces, the Roman soldier became too weak to bear the ancient armor. The deserted ranks of the legions were replenished with the hardy barbarians from the frontier provinces. The name of emperor had lost its significance, by his deserting the field for a more easy and agreeable residence in the capital ; but his warlike character was redeemed by the accession to the purple of the Thracian peasant Maximin, who during his reign disdained to visit either Rome or Italy.

* Johnson's "Cyclopædia," vol. iii, p. 1707.

† Gibbon, "Decline and Fall of the Roman Empire," vol. i, p. 27.

In this mighty tragedy the time had come for the final act; the stage was set, and all awaited the entrance of the actors. When Alaric and his savage Goths descended upon Rome, they were met with as little resistance as are the play-warriors upon the smaller stage. The Romans of old were not there to oppose the barbarians; many had been destroyed by wars, "but these," as Draper says, "were an insignificant proportion to that fatal diminution, that mortal adulteration, occasioned by their mingling in the vast mass of humanity with which they came in contact. . . . Whoever inquires the cause of the fall of the Roman Empire will find his answer in ascertaining what had become of the Romans." *

The early union of the neighboring tribes into the Roman state was a union of similar elements, which became strengthened by numbers, without being weakened by conflicting natures. Their subsequent conquest of the Greek colonies gave them an element which encouraged the development of art and learning, and was still of the same race as themselves, with a civilization of a like genius. Thus the Roman state grew in strength as it increased in size. Her victorious arms then humbled city after city, and nation after nation, till the savage tribes of Europe and the civilized nations of Asia and Africa acknowledged the rule of the mistress of the world. Year after year the flower of the Roman youth were marched to her distant colonies and died upon foreign fields; and in return the Gauls and Thracians, Syrians and Egyptians, were brought to Italy and Rome. The art, learning, and civilization of Rome, which had thrived upon their native soil, and had each year grown more deeply rooted, were like plants pulled up and strewed broadcast over the earth, to take root where they could, or to be crowded out by the more vigorous but rank native growth. Those that were left became weakened by the rude foreign growths that were brought and placed beside them. Only an occasional seed was preserved, to finally bear fruit in future ages. The individual representatives of the civilization of Rome were absorbed in the much greater mass with which they had surrounded themselves, as the fresh waters of the river are lost in the greater volume of the ocean.

The Spanish invasion of Mexico affords a similar illustration of the distinctive results following the union of different civilizations. The Mexicans were a homogeneous people, having similar wants, instincts, and capabilities. Undisturbed by foreign influence, they were slowly developing to a higher stage of civilization—a condition of greater good for a larger number. In the sixteenth century there was every indication of an increasing population and an advancing intellectual state. The mixed population to-day of the valley of Anahuac is but a fraction of the numbers who opposed the arms of Cortes. The Spaniards and the Aztecs were too unlike to be brought

* "Intellectual Development of Europe," vol. i, p. 255.

harmoniously into one society. The government and customs of neither were suited to both. Forced together as they were, there could only result a struggle for supremacy, and the gradual assimilation of the more yielding characters of each. Passions and vices were earlier the habits of mankind than reason and virtues: the former were, therefore, the more constant, the latter the more readily destroyed. The mental characters and customs were more alike also among primitive than among advanced societies, and would more readily assimilate. So we find, for many generations after the union, that the new society is lower in the scale of civilization than were either of the parts which composed it.

Now, after three and a half centuries, the conflicting elements have been so far eliminated, and the remaining parts have become so far assimilated, that the society consists of a people who are of an increasing homogeneity, and which represents a civilization that has been reared upon an Aztec foundation, with a Spanish superstructure.

If, however, these general principles be admitted—that societies by mingling produce a new society having the characteristics of each of its parts, and the persistence of the characters of the respective parts are controlled by laws, the operation of which may be approximately determined by a knowledge of the several societies—it may still be objected that the application of the principles to the influence of the Chinese in the United States would lead to a conclusion favorable to their immigration. Why, it may be asked, is not the civilization of the Chinese one which would affect ours for the better? With an antiquity which fades away in the prehistoric past, it still exists with the apparent vigor of youth, and controls under one government a larger population than has existed in any nation which history mentions. Why are not its antiquity and success an exemplification of the survival of the fittest? We have received from the Chinese silk, tea, and paper; and by the invention of gunpowder and printing they have added to those great agents of civilization, the sword and the pen, a thousand-fold. We have been told that the dream of the Western political reformer was long since realized among this people whom we teach our children to call semi-civilized; that government offices, from the highest to the lowest, the most prized honors and social position, are all based upon an educational qualification. By the adoption of the Chinese system England, and, following her, the United States, are endeavoring to advance the efficiency and to raise the moral and intellectual standard of their civil services. For these and many other products of the civilization of the Chinese they must always command the respect of Christendom. Is not, then, the conclusion justified that, if we have heretofore profited so much from our slight knowledge of that people, we may be indefinitely benefited by their absorption into our body politic?

A reply to these objections can only properly be made by such a

review of the history and institutions of the Chinese as will indicate the genius of their civilization.

In that period of the existence of the human species when all races were occupied with the common struggle with the elements and with their four-footed rivals, the ancestors of the Aryan and Mongolian, perhaps, possessed no distinguishing characters. If they have descended from a common stock, they separated at a period before the present races of the world had yet become differentiated. There is no evidence which indicates a later connection between our race and the Chinese. Language, the most certain guide to prehistoric history, affords decided testimony to this conclusion. The study of the Aryan family of languages has shown that the complicated forms our words now have in their divisions into parts of speech, in their inflections, in their prefixes and suffixes qualifying the roots, and in the general prevalence of polysyllabic words, are but a development from a form of language in which all words were simple sounds for simple things or thoughts—were monosyllabic.

Long before our Aryan ancestors left their early home in Central Asia and commenced their great Western emigration, our language had passed out of the monosyllabic stage. But the Chinese may be said still to retain its simple monosyllabic form ; from which fact it has been thought by some to be "the primitive language." Whitney tells us that "it is a language which possesses neither inflections nor parts of speech, and it has changed less in four thousand years than most others in four hundred, or than many another in a single century. . . . It is, in certain respects of fundamental importance, the most rudimentary and scanty of all known languages."*

The testimony thus afforded by these languages proves, beyond a doubt, that the Aryan race could have had no union with the ancestors of the Chinese later than that remote past when our language was in a like state of monosyllabic simplicity. From that remote time, when the savage ancestors of our race shaped their rude weapons of stone, the Chinese have been developing upon one small portion of the earth—we have spread over much of the rest. They have been comparatively isolated, and their growth has been therefore more homogeneous, constant, and persistent in one type. From the earliest time to the present, the same people, guided by the same impulses and controlled by the same surroundings, have developed in an unbroken course.

As some of the characteristics of families of languages are found to be less variable than many of the physical characteristics of races, the former is a better guide in classifying the human races than the latter. A comparison of the language of the Indo-European peoples with the language of the Chinese affords the strongest reason for classifying them as different races. This conclusion receives constant

* "Language and the Study of Language," p. 334.

corroboration upon an examination of the civilization of the Chinese, the genius of which is forcibly illustrated in their government and religion.

The family is the first social aggregate, and the natural head of the family is the head of the primitive society. As families unite together for common interests in defense or attack, one of the heads of the family is chosen as leader of the tribe. A similar union of tribes forms a nation. The paternal form of government thus naturally becomes the form common among early societies. Particularly is this likely to be the form adopted by those tribes whose instincts and surroundings early lead them to an agricultural life. With these the head is not chosen for his bravery and success in arms—which are lessened instead of being increased by his increasing age—but he is chosen rather for his counsel and advice, to which age but adds wisdom and authority.

Early superstitions and religious beliefs receive their form from the same model of the family. The simple interpretation of dreams and various experiences lead the uncivilized man to a belief in the existence of an accompanying spirit, or a double existence. When he calls out among the hills, an answering voice calls back ; and, while gazing into the placid waters of the lake, he sees a shadowy image of himself. Thus to him death is but the separation of the body and the spirit ; though the spirit still hovers around its former dwelling-place, and retains an interest in the affairs of its former companions. The father, who was the absolute ruler of the family while living, thus carries his authority beyond the grave. At the funeral, as at festivals, food is offered to his spirit ; and his favor is solicited and enmity propitiated by offerings and sacrifices. As the spirit of the father becomes the tutelary deity of the family, the spirit of the chief becomes the tutelary deity of the tribe, and the spirit of the king receives the worship of the nation.

This primitive form of religion and government, originating in the smallest social aggregate, is to-day represented in the oldest and largest society upon the earth. The Emperor of the Chinese is the father of four hundred million people ; and their universal religion—whatever other forms are observed with it—is ancestor-worship.

The government still maintains its ancient simple paternal form, with only those changes which have been necessary in adapting the family code to so vast a nation. Descending from the imperial throne, the whole government is found to be formed upon the same plan, repeated over and over. The viceroy of a province, the governor of a city, the elder of a village, and the father of a family, are each based upon the extension of the last. This relationship finds recognition in the "Ta Hioh," one of the four classic books of the Chinese, which is summed up as tending to "the improvement of one's self, the regulation of a family, the government of a state, and the rule of an em-

pire." * The paternal idea is strengthened by education, from the commencement as children to the attainment of the highest literary degrees conferred upon mandarins. In the "Classic of Three Characters," one of four small tracts that are placed in the hands of Chinese children, they are taught that "filial piety and a due regard to elders we consider as holding the first place, the acquisition of knowledge we rank in a secondary place." † Again, in one of those canonical works which form the basis of Chinese education, religion, and government, the opinions of Confucius are recorded upon the same subject. Being asked "whether in the virtue of the sages there was not something greater than filial piety," he replied: "Of all (creatures with their different) natures produced by heaven and earth, man is the noblest. Of all of the actions of man there is none greater than filial piety. In filial piety there is nothing greater than the reverential awe of one's father. In the reverential awe shown to one's father there is nothing greater than making him the correlate of Heaven. ‡ There is in all of their institutions a recognition of the paternal model; it is constantly recited, in their religious worship, in their state ceremonies, in their education, and in their literature. Sir John Davis says: "There is nothing more remarkable in their ritual and in their criminal code than the exact parallel which is studiously kept up between the relations in which every person stands to his own parents and to the Emperor. For similar offenses against both he suffers similar punishments; at the death of both he mourns the same time and goes the same period unshaven; and both possess nearly the same power over his person." #

The genius of the Chinese civilization, which is characterized by the greatest persistence in primitive or early forms, is illustrated equally in their religion as in their government. The two are, indeed, to a great degree united. The duties which are paid by all to their parents and sovereign while living, are continued in their worship after death. As this has been taught by the sages, and forms the foundation of the government, it is allowed by the teachers to be consistent with all forms of faith. Ancestor-worship has thus become the universal religion, to which all newer forms have adapted themselves. All forms of faith are at least tolerated, so long as no organization is affected, or no doctrines taught which are considered dangerous by their strength, or opposed by their influence to the political power. And the strict interference with any attempt by religious societies to usurp any temporal authority has conduced to that common toleration and individual independence of belief which make it possible to accept the not inconsistent parts of various creeds. We are

* Williams's "Middle Kingdom," vol. i, p. 516.

† Morrison's "Horæ Sinicæ," p. 7.

‡ Legge, "Sacred Books of China," "Hsiao King," p. 476.

Davis's "China," vol. i, p. 24.

not surprised, then, to read the statement of the Abbé Huc that "the whole nation has proclaimed this famous formula, with which everybody is satisfied—the three religions are one. Thus, all the Chinese are at the same time partisans of Confucius, Lao-tze, and Buddha."* The institutions and faith which were handed down by Confucius have been embraced by the Taoists, Buddhists, Mohammedans, and Christians, in turn. And it may reasonably be asserted that any form of religion which hopes to prevail in China must permit the practice and belief of their popular superstitions. In the seventeenth century, the Catholic Church was flourishing in China, and made—nominally, at least—many converts. As it grew stronger, however, it became less tolerant of these native ceremonies which it had at first allowed. This produced an immediate discussion between the Emperor and the priests. The matter was referred to the Pope, and Clement XI settled the dispute, and his cause, by decreeing that the Chinese ceremonies should not be permitted the proselytes. The Emperor thereupon banished the missionaries, and upward of one hundred thousand souls were lost to the Church.

This remarkable preservation of the most primitive form of government and religion, in so vast and ancient a nation, well illustrates the law of heredity—that characters which have been long transmitted are more persistent than those of more recent origin. All newer forms have yielded to those ancient institutions and beliefs which originated before their civilization, and, aided by unchanged surroundings, have been developed in a nation composed of a homogeneous people and transmitted by inheritance to the present time.

The practical arts of the Chinese, which have added to the comforts and luxuries of the Western nations, from the time of the Greeks to the present day, will appear, upon consideration, to be unchanged in their effects upon our society, either in the event of an entire exclusion or an unlimited immigration of the people. It would be difficult to imagine a nation, existing for forty-five centuries, having any claim to being called civilized, which had not made many useful discoveries and inventions. This would be still more difficult to understand of a people like the Chinese, whose instincts have always directed them in the paths of peace. So we find that, in the course of centuries, they have made no mean progress in the useful arts, however slow that progress may have been. The Western nations seem to have derived their early knowledge of many useful inventions from the Chinese; among these, not the least important are those mighty engines of civilization—gunpowder, paper, and printing. The history of these inventions, however, but adds another illustration to the different characters of the civilizations of China and Christendom. It shows, equally, their continued adherence to old knowledge, with no disposition to improvement; and our inventive and progressive genius, in

* "Chinese Empire," vol. ii, p. 98.

improving to the highest degree those suggestions which we have received from them.

As they have taught us many useful arts in the past, it is not improbable that we may learn from them still others in the future. But inventions may be adopted by those who wish them ; customs are acquired by contact with those who practice them. Arts may be learned from a distance, or by the casual contact of travel, with equal certainty and greater safety than by a union of the societies. Inventions and arts are regulated in their distribution, rather as commerce is, by the laws of supply and demand, than by the involuntary influence of social contact.

The most complete account of the customs and institutions of the Chinese would but add to the testimony here presented of the wonderfully conservative character of their civilization. The development of a society from a single race, under one government, with constantly similar surroundings and but little subject to the influence of foreign races or nations, has produced a homogeneous society, which is constant in the repetition, for generation after generation, of the characters which marked it at its commencement.

The nations of the West, on the other hand, have developed, with ever-varying surroundings, and under the influence of various nations and races. We have our language from India, our alphabet from Phœnicia, and our religion from Israel. Our civilization bears the impress of the various peoples who have spread around the Mediterranean Sea, from the builders of the pyramids of Egypt to the Moorish philosophers of Cordova.

In government, the Chinese have always been well content with a monarchy ; with the Aryan nations there has been an ever-increasing tendency to democracy. This difference of civilizations is made intelligible only by that theory which is an explanation also of the physical varieties of races. It is the effect of development through ages, under the influence of different environments. There is more than an analogy between this development of the civilization and the physical characters of a race. It is the same relation that exists between the mind and the brain ; they can not be separated. The mental characters which determine the genius of a civilization are thus but a manifestation of the physical organization of the individuals composing the society. The characters of the civilization and of the physical organization must, therefore, be controlled by the operation of the same laws. A change in one is the cause or the effect of a change in the other.

The application of the law of heredity, that older characters are more constant than those of later development, we find is exemplified in the unparalleled persistence of the ancient habits and institutions of the Chinese ; and to such a degree is this extended, that it seems an illustration of that persistence of characters, once beneficial, after

they have become injurious. The paternal system, which in a small and rude society was of the greatest benefit, is now so strongly inherent in the Chinese character as to be an injury to society by retarding its development; and perhaps, also, by preventing the introduction of Western knowledge and arts.

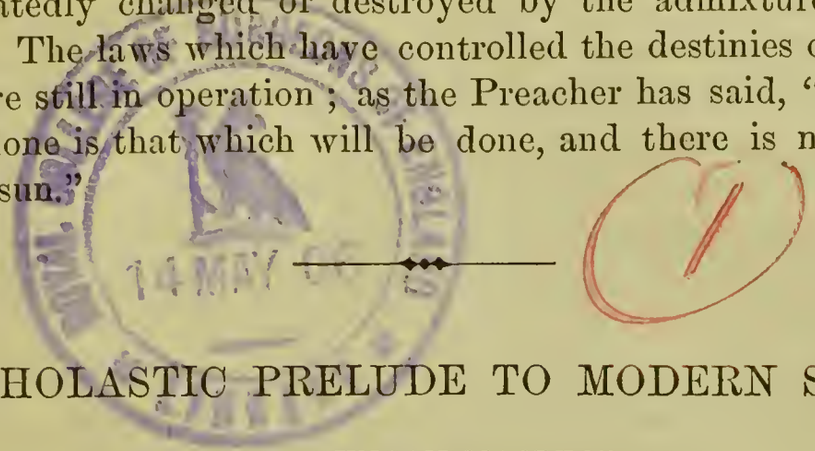
That vital relation which exists between the mind and the body would of itself lead us to expect the operation of the same general laws in social development which control the evolution of organisms. We are led to the same conclusion by an examination of the history of the past and by the social condition of the present. Their operation in the future follows as a necessary corollary. The union of the civilizations of China and America, which differ as their races differ, would produce a society with parts so fundamentally antagonistic that permanent national existence—for which homogeneity is necessary—would be impossible. Assimilation could be effected only by the gradual and slow change of the more yielding characters of each. In the involuntary conflict ensuing, those characters which originated before the dawn of an ancient history, and have been strengthened through the inheritance of unnumbered generations, would persist with greater force than those new and changing characters which seem by comparison like the fashions of a season. The manners and customs which were described by the Arabs in the ninth century the same as they are by the travelers in the nineteenth century would be little affected by the changing forms of the society around them. The new society would assume more the character of its persistent than of its more yielding part. Intense conservatism would check the progress of reform and improvement. That liberty of personal thought and action, the assertion and exercise of which have secured the freedom and independence of governmental or religious control we now enjoy, would receive a severe shock, were our society composed in part of a people whose first and highest duty has always been to obey and depend implicitly upon an authority, and who have no word for liberty in their language.*

If the further development of our civilization is to be desired, it must be guarded from the retarding influence of a different race. If our institutions and governmental principles are worthy of preservation, they must be protected from a people who represent in all the instincts of their nature different feelings and forms. If we ignore the plain teachings of history upon the effect of the mingling of societies composed of different races, or having different civilizations, and, as is commonly the case with individuals, will learn only from our own experience, the experience is likely to come too late for us to profit by it.

The permanence of a civilization and of a nation depends upon their homogeneity. The Chinese present their uniform and unparalleled

* Williams, "The Middle Kingdom," vol. i, p. 321.

record of centuries as having escaped the influence of great or frequent immigrations, while the short-lived nations of the West have been repeatedly changed or destroyed by the admixture of foreign elements. The laws which have controlled the destinies of nations in the past are still in operation; as the Preacher has said, "That which has been done is that which will be done, and there is no new thing under the sun."



THE SCHOLASTIC PRELUDE TO MODERN SCIENCE.*

By HENRY DUNCAN MACLEOD, M. A.

IN the latter half of the sixteenth century a wondrous change came over the spirit of the nation which then held the foremost place in culture and civilization.

After twelve centuries of existence, the Niobe of nations had fulfilled her destiny. By the middle of the fifth century her empire, which had extended from the Euphrates to the Tagus, and from the Forth to the cataracts of the Nile, had seen province after province rent away from her, and had shrunk within the limits of Italy. Rome, which had not seen a foreign foe for seven centuries, had been four times sacked by the barbarians. The free yeomen of the bright days of the republic had perished in the civil wars. The land was parceled out among a small number of gigantic proprietors, and cultivated exclusively by slaves. Tillage had nearly ceased, and all the supplies of corn came from the provinces. With the loss of these the supplies failed, and the population was reduced to the lowest depths of misery. War, pestilence, and famine desolated whole provinces. The army was a host of mercenary barbarians. In 476 they peremptorily demanded that one third of the lands of Italy should be divided among them. The youthful Emperor had the spirit to refuse this demand, and took refuge in Pavia, where he was immediately besieged: the town was captured and pillaged: and the Emperor laid down his uneasy crown. The Senate ignominiously surrendered the vacant authority to the Emperor of the East; and Odoacer, the military commander, reigned in Italy. One third of the lands was immediately confiscated and divided among the successful mutineers.

Sixteen years afterward, a new swarm of barbarians under Theodoric conquered the country and effected new confiscations and settlements; and for thirty years the land enjoyed peace and prosperity under the reign of the wise Theodoric. But in 568, Alboin, King of the Lombards, introduced a new host, and founded a dynasty which

* Abstracted from Macleod's "Elements of Economics," Book I, "History of Economics." D. Appleton & Co.

lasted two centuries, until overthrown by Charlemagne and the Franks; and they again were succeeded by the Germans, in 962, under Otho the Great.

Thus, during the space of five centuries, Italy was overrun by five successive hosts of invaders: but, with great sagacity, they left the Roman municipal institutions untouched: so that while the forms remained the population was almost entirely renewed. Moreover, the invaders on all occasions favored emancipation, so that by the eleventh century slavery had died out, and the land was once more inhabited by a free people.

Thus, after the gestation of five centuries, the conquering races and the conquered had become amalgamated into one people, and a new nation arose which exhibited such a transformation as had never before been exhibited in the history of the world. The land which had been held by the most prosaic and unimaginative of nations became the mother of all the arts and of all the sciences.

The cities of Italy, enjoying peace and settled government under the Germanic emperors, rapidly progressed in prosperity and wealth, and began to extend their commerce throughout Europe, and became habituated to self-government under the decaying house of Franconia.

But when the Hohenstaufens, a more energetic race, succeeded, Frederick Barbarossa, one of the ablest sovereigns of the middle ages, attempted to reimpose upon them the yoke of the empire. The Lombard cities took up arms in their own defense. Barbarossa was at first successful: he captured Milan and razed it to the ground. But he was finally vanquished in 1176, on the field of Legnano; and Italy became all but nominally independent.

The energies of the people being thus aroused, soon developed themselves in every direction. First architecture, then sculpture, then painting, then poesy, was called into existence; and, during the space of four centuries, Italy produced such a galaxy of illustrious names in the arts as no other country can boast. The powers of Nature seemed to culminate in Michael Angelo, and then decayed.

The day that Michael Angelo died, Galileo was born.

At the same time the study of jurisprudence revived. The great Code of Justinian had been published during a short period while Italy was reunited to the Eastern Empire, and then Justinian caused his code to be adopted throughout the whole empire. But the original Latin soon fell into desuetude in the East, and was superseded by Greek compilations; and was finally set aside by the revised code called the Basilica, published in Greek in the ninth century.

In the troubled state of Italy the study of jurisprudence was naturally much neglected. Each separate race of invaders had its own code of laws—founded, however, on preceding Roman codes; and every nationality was allowed to follow its own laws. Consequently, though the Code of Justinian never ceased to exist, its effects were

much weakened. At the beginning of the twelfth century a great school of law was founded by Pepo and Irnerius at Bologna, and for two centuries produced an illustrious line of jurists, to which students flocked from all parts of Europe.

But the most remarkable and original product of the middle ages was the Scholastic Philosophy ; and, as the Baconian philosophy was the reaction against it, it is necessary to give a brief outline of it.

Socrates was the first to perceive that all systematic reasoning in science and philosophy must be based upon general concepts, ideas, or definitions of terms. The dialogues of Plato are full of discussions on the meanings of terms—the Good, the Beautiful, the Holy, the Just, and numerous others. If any action was said to be holy or just, it was first of all necessary to define the holy, or the just. Thus the Platonic dialogues are full of inductive reasonings as to fundamental concepts. Now, when a certain moral concept is formed in the mind, it does not by any means follow that it should be realized in any actual person, nor that it should be seen in any action. It is quite possible to form a mental concept of the holy or the just, without there being any holy or just person, or any one doing a holy or just action.

From this it followed that general concepts might have an actual and real existence without being embodied in any concrete form. Plato argued by analogy from the moral to the physical world. He held that all nature was framed in accordance with certain ideas, or notions existing in the Divine mind, which were quite independent of any particulars. Thus, there was an idea or notion of a man, horse, etc., before there was any actual man or horse—though he was rather staggered at the notion of there being eternal ideas of mud, hair, dirt, etc. Thus, besides the world of spiritual existences, Plato held that there is also a distinct world of invisible, self-existent, eternal, and unchangeable ideas. These, with some variations, were the doctrines which were called *realism* in the middle ages. Aristotle, the disciple of Plato, combated these doctrines in several of his works. He maintained that these universals, as they were called, could not be separated from their particulars : he denied that universals could have a separate reality from the particulars. Hence the universals were mere names for certain particulars. This, somewhat modified, was termed *nominalism* in the middle ages.

The Greeks were the first to discover that there is an innate power of discerning *truth* in the human mind ; and that there is a science of truth, which can be reduced to a systematic form. This science is termed *logic*. Zeno, of Elea, was the first to employ this science, to prove the fallacy of the arguments of his opponents. It was much used by Socrates and Plato in their discussions and dialogues ; but Aristotle was the first to reduce it to a systematic form. He first showed that all error can be exposed and all truth set forth in a systematic form.

Logic or dialectic, therefore, in the hands of Aristotle was a mere method of testing the truth of philosophical systems: he never supposed that syllogism could be applied to the discovery of the truths of physics. Both he and Plato foreshadowed and adopted the inductive method for the discovery of truth; in which, however, he was not very successful.

The scholastic philosophy of the middle ages was the attempt to combine the idealism of Plato with the logic and dialectics of Aristotle: but, unfortunately, it attempted to apply the syllogistic method to the discovery of truth.

When Christianity became known to philosophers, the Platonists perceived that there was much in it in accordance with their system. They were the first of philosophers to adopt it, and they endeavored to combine it with their own philosophy.

As the general intellect decayed in the decadence of the Western Empire, all originality vanished. The highest literature fell into oblivion. Theology was taught from books; and consequently writers confined themselves exclusively to commenting on the usual text-books. St. Augustine and some of the Latin fathers were still read; but the whole course of philosophy consisted of some parts of Aristotle's "Organon," Plato's "Timæus," and a few tracts of Cicero and Seneca. A few lessons in grammar and logic, with just enough mathematics and astronomy to calculate Easter, were the highest instruction. The age of Charlemagne was the nadir of the human intellect. Soon after him appeared the first original genius of the middle ages. Paschasius had asserted the doctrine of transubstantiation. John Scotus Erigena was employed to refute it. He was a realist and a mystic: his work marked the revival of metaphysical speculation.

About the middle of the eleventh century Berengar, Archdeacon of Tours, revived the eucharistic controversy, adopting the same side as Erigena. Berengar's doctrines, founded upon reasoning, and supported by much profane learning, greatly agitated the Church; and he was combated by Lanfranc in the name of authority, and afterward by Anselm, who endeavored to reunite the claims of reason and faith. These metaphysical controversies about the deepest mysteries of faith revived the old contests of Plato and Aristotle.

Realist views were then generally current; but about the same period Roscelin, Canon of Compiègne, strongly adopted the nominalist side. In discussing the mystery of the Trinity he gradually lapsed into tritheism. The Church was shocked and alarmed, and in 1092 he was condemned by the Council of Soissons, and obliged to leave France. The impiety which resulted from nominalism produced a reaction in favor of realism. Anselm and William of Champeaux thundered against him on the realistic side.

But a doughty champion revived the fortunes of nominalism. Abélard pointed out the absurd consequences of realism, and William

retired from the field. Three thousand disciples carried Abélard's fame and doctrine into every country of Europe. But the rage for definition and dialectics led Abélard into the heresies of Berengar and Roscelin, and he was silenced and consigned to the cloister.

These controversies had fairly roused the spirit of metaphysics, and several champions appeared on either side : when an unexpected discovery added tenfold fuel to the flame.

Athens had been for centuries the university of the Roman world. The narrow policy of Justinian closed her schools, and the teachers were scattered throughout the world. A learned colony had settled at Edessa on the borders of Syria and Mesopotamia, and founded a flourishing school of Greek science and philosophy. In process of time Edessa fell before the conquering Moslem. The dynasty of the Abassides came from Khorassan, where learning had long been held in honor. Almanzor, and his successor Haroun-al-Raschid, founded schools at Bagdad, and diligently sought out the monuments of Greek learning, and caused them to be translated into Arabic ; and its literature was enriched by translations of the Greek works on mathematics, astronomy, mechanics, Euclid, Ptolemy, Hippocrates, Galen, Dioscorides, and especially Aristotle and the neo-Platonists.

Africa and Spain rejected the Abasside dynasty, but equally cultivated the arts and sciences. Colleges and schools were founded in every city of Spain. Magnificent libraries contained translations of all the Greek masterpieces. Thus for three centuries, while Europe was plunged into the lowest depth of barbarism, the arts and the sciences flourished in the Mohammedan world from Khorassan to the Ebro. Then arose a great series of Moslem doctors and philosophers, Alkendi, Alfarabi, Gazali, and especially Ibn-Sina, Ibn-Badja, Ibn-Thofail, and Ibn-Roshd, known to the infidels respectively as Avicenna, Avempace, Abubazer, and Averroes. These men annotated and commented upon the entire works of Aristotle.

The same spirit of inquiry agitated the Jewish world. In the eighth century the Karaites broke away from the Talmud, and asserted the right of reason to judge faith. To combat the growing heresy, the school of Sora was founded near Bagdad, and they were equally obliged to cultivate dialectics. Saadia (892–943) made a strong effort to reconcile reason and revelation.

The Jews in Spain were equally active, and the philosophy of Ibn-Gebirol (Avicebron), rejected by his own nation, convulsed the Christian schools. In the twelfth century an orthodox reaction began. Juda Hallevi denied the power of reason to judge religious mysteries. Jewish philosophy reached its highest point in Moses Maimonides.

Thus, by a curious coincidence the Jewish, the Christian, and the Mohammedan worlds were simultaneously immersed in dialectics, and agitated and convulsed by the perennial conflict between reason and faith.

While the minds of the three great religious communities were thus distracted, some rays of Mohammedan learning penetrated into the Christian schools. A few travelers had brought back specimens from the East. The Crusades still further stimulated intercourse between the hostile creeds. Arabic versions of Aristotle were imported along with bales of merchandise into Sicily, Italy, and the south of France; and some diligent scholars translated the Arabic works of science into Latin. Raymond, Bishop of Toledo (1130–1150), caused several of the works of Avicenna, Gazali, and Alfarabi to be translated into Latin; and Michael Scot and others translated the Arabic versions of Greek works into Latin. All this mass of new literature gave an immense stimulus to metaphysical controversy. The intoxication of mind produced a flood of discussion which threatened to be fatal to orthodoxy. The first scholastics professed themselves devout sons of the Church, but the inevitable tendency of free inquiry was to lead them further and further away from orthodoxy. The doctrines of Avicenna, Averroes, and Avicebron convulsed the Christian schools; and the teaching of Aristotle seemed to lead to the plainest pantheism and materialism.

The Catholic Church was now thoroughly aroused and alarmed. It was, indeed, shaken to its foundations; and, as Aristotle seemed the original source of all these heresies, he was formally condemned by the Church in 1204, 1209, and 1215. Thus in all the three religious communities the appeal to reason was dangerous to faith; and the Aristotelian philosophy was a terror equally to orthodox Jews, to orthodox Mohammedans, and to orthodox Catholics.

The Catholic Church seemed on the very brink of destruction; the scandalous lives and the venality of the court of Rome shocked all Christendom. Every country swarmed with heretics in revolt against the tyranny of the priesthood. But the Pontiff was equal to the crisis. The Crusades had familiarized the followers of the meek and gentle Jesus with the idea that the slaughter of infidels was grateful to the Creator. And heretics were worse than infidels. Accordingly, Innocent III carried fire and sword into the fairest provinces of Christendom.

A great revolution was at hand, and the Church was saved in the very crisis of her existence. In the same year, 1206, Dominic, a Spaniard, founded an order of mendicant friars at Toulouse, and Francis, at Assisi. They were bound to devote themselves to poverty and preaching. The new orders spread with marvelous rapidity, and in a very few years all Europe was filled with them. They were devoted to the defense of Catholic dogma. Each order cultivated the most profound learning, and studied the pagan philosophers to profit by them and to confute them. The rival fraternities vied with each other in celebrated names. The Franciscans boasted Alexander de Hales; the Dominicans, Albert of Cologne, surnamed the Great.

These two, with William of Auvergne, Bishop of Paris (1218–1248), consolidated that system called the Scholastic Philosophy, which saved Catholicism from the heretical wisdom of the Arabians.

The greatest of the three was Albert, and twenty folio volumes attest his industry. He commented on all the works of Aristotle. Albert perceived that general concepts are at the base of all philosophies. He held that they existed independently of the mind ; but he did not recognize a being called Humanity independent of actual human being ; nor of Animality beyond actual animals. He held that the genus is an essence which only exists in particulars, but does not depend upon them. It emanates from the mind of God. Thus humanity and all other essences are the concepts, ideas, or forms existing in the mind of God, realized in individual beings. Hence, to find the origin of the universal, it was necessary to go back to the first cause. Albert was thus a modified realist. All realities were supposed to exist as concepts of the Divine mind ; and also all concepts of the Divine mind had corresponding realities.

By this means all knowledge of external nature was to be found in the concepts or ideas of the mind ; and these mental abstractions were supposed to be real physical existences.

Now, theology is the creation of the human mind, and consists in abstract concepts ; and these were formed into a logical system of dogmatic theology. This being granted, these great master-minds saw the prodigious use of the Aristotelian logic in forming the subject into a great scientific system. In fact, if the freedom of inquiry could be curbed, and opinion restrained to certain orthodox fundamental concepts, there was nothing like the Aristotelian logic for reducing them to systematic form. Hence the Aristotelian logic, instead of being adverse to the Church, was now its greatest defender.

The greatest of all the scholastic doctors was Thomas Aquinas, the pupil of Albert of Cologne ; and his works are the very incarnation of the scholastic philosophy.

It was then supposed that theology comprehended every other science ; and physics was framed in the same spirit as theology. All physical science was supposed to be founded on certain mental concepts, which were supposed to be real. But all reference to Nature herself was prohibited, as savoring of heresy, and from fear of contradicting some doctrine of theology. Aristotle's theory of matter and form was adopted—the matter being the physical substance and quality of things, and form being that which distinguishes them into different classes.

Thus all physical science was reduced to syllogisms ; and it was supposed that by varying these all physical truth might be discovered. The system was therefore entirely *a priori ;* it began with the highest abstractions—pure fictions of the mind—and reasoned deductively from causes to effects. By this means the idealism of Plato, together with

the logic of Aristotle, was utilized in the service of the Church, and the union of the Church and philosophy was irresistible, and enthralled the human mind for three centuries.

Thus the logic of Aristotle, which was never intended as anything but a defense against philosophical error, was turned into a system for the discovery of truth and scientific investigation. Aristotle himself would have been the first to protest against this misuse of it. The labors of the men were prodigious, but they were utterly barren of results—as barren as the labor on the tread-mill.

HOW ANIMALS BREATHE.

By HERMAN L. FAIRCHILD.

II.

SPECIAL ORGANS OF THE FOOD-TRACT.—Another class of respiratory organs may now be distinguished, namely, those developed directly from the alimentary canal. Here belong the more highly specialized organs of the vertebrates.

Aquatic Organs of the Food-Tract.—The gills or branchiæ of fishes are analogous in position and structure to those of crabs, but are morphologically different, as they are not developed from the skin directly, but from the lining of the pharynx. A powerful heart impels the blood rapidly through the gills, while these are bathed by water-currents produced by the pumping action of the mouth ; so that rapid and constant changes are effected in both the blood and the aërating water. The branchiæ are comb-like fringes of minute blood-vessels,

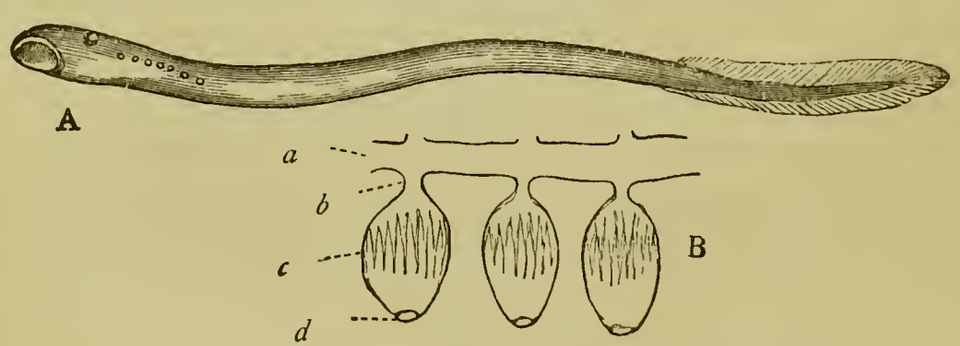


Fig. 1.—A, Lamprey (*Petromyzon*), showing the sucking-mouth and the apertures of the gill-sacs. B, diagram to illustrate the structure of the gills in the Lamprey : *a*, pharynx ; *b*, tube leading from the pharynx into one of the gill-sacs ; *c*, one of the gill-sacs, showing the lining membrane thrown into folds ; *d*, external opening of the gill-sac. (In reality the gill-sacs do not open directly into the pharynx, but into a common respiratory tube, which is omitted for the sake of clearness.)

placed on bony arches, having a complex structure, and beautifully adapted to their purpose of exposing a great amount of blood in small space and in brief time.

It is impracticable to describe at length the various arrangements

of gills in the different groups of fishes. Their origin from the food-tract is clearly shown in the lowest fish, the worm-like *Amphioxus*, which has gills formed from a large, barrel-shaped pharynx pierced with transverse slits through which the water is drawn by cilia (Fig. 2, page 645 of the September, 1881, "Monthly"). This creature differs from all other known vertebrates in the possession of cilia as the means of renewing the water.

The lamprey and hag, and the shark family, have the branchiæ in separate pouches developed from and connected with the pharynx; while most common fishes possess the familiar form.

In the embryonic state, the shark has external gills—long, filamentous appendages projecting through the gill-slits. But gills of this nature have a more remarkable and enduring character in the amphibia. In the toads, frogs, and most salamanders, these external gills give place early in life to internal fish-like gills, which are, in turn, replaced by lungs. But in certain species these external organs persist throughout the life of the animal; and the group is consequently known as the *Perennibranchiata*. The *Proteus*, of Austrian caves, has three pairs of scarlet fringes on each side of its neck. In the *axolotl*, of Mexico, the six gills are somewhat arborescent; while in the *Menobranchus*, found in the United States, they are plume-like. The *Siren* of the Carolina rice-swamps is another member of this group.

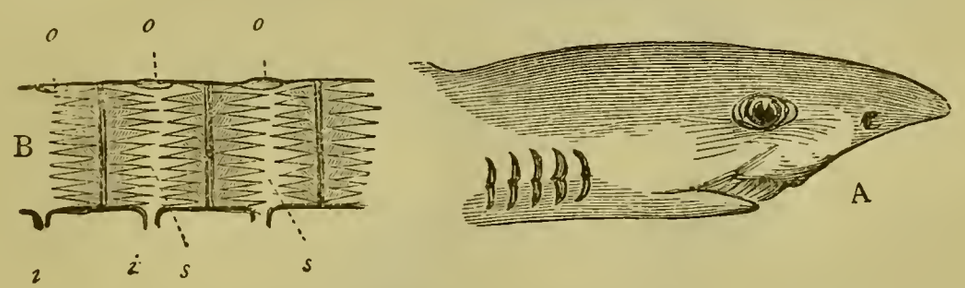


Fig. 2.—A, Head of a Piked Dog-fish (*Spinax*), showing the transverse mouth on the under surface of the head, and the apertures of the gill-pouches. B, diagram of the structure of the gill-pouches: *o*, *o*, external apertures; *i*, *i*, apertures leading into the pharynx; *s*, *s*, gill-sacs, containing the fixed gills.

These plumose appendages upon the neck of the perennibranchiates would seem, judging simply by their appearance, to be as truly a part of the outer skin as any gills of the invertebrates. Indeed, such relation is much less apparent in the crabs and in the true snails. But, for reasons lying deeper than mere appearance, the gills of amphibians are classed with food-tract organs. However, this involves a nice distinction, since the food-tract and skin are fundamentally one.

Aërial Organs of the Food-Tract.—Dismissing now the water-respiratory organs of the food-canal, we pass to the consideration of its special air-breathing organs.

The habit among fishes of swallowing air has already been mentioned. It is probable that in many fishes this air, or a portion of it, is simply passed through the gills, or perhaps is held in the oral cavity to aërate more highly the water that bathes the gills. However this

may be, free air is so essential to many fishes that they die if prevented from obtaining it, especially in hot weather.

There is no organic reason why fishes could not breathe air if the gills could be kept moist and free. Indeed, there are a few fishes which even pass a great part of their lives out of water. "Such are the two genera, both belonging to the *Gobiidæ*, *Periopthalmus* and *Boleopthalmus;* these skip along close to the water-line on the seashore, where they hunt for mollusks and insects. In their branchial

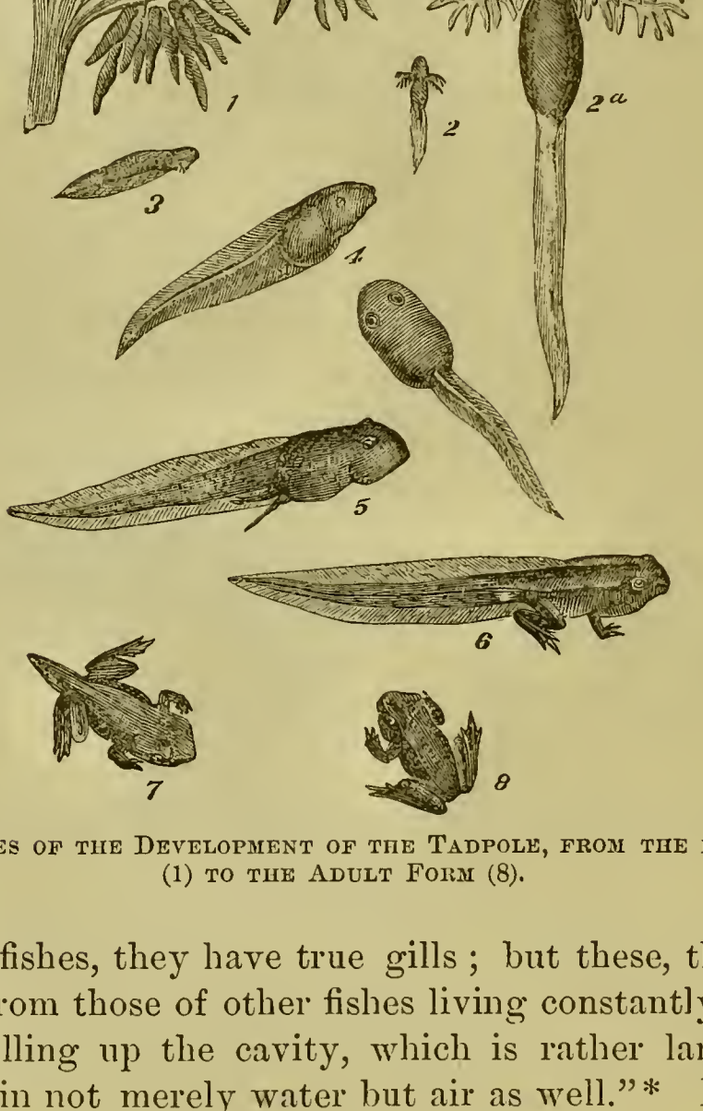


Fig. 3.—Eight Stages of the Development of the Tadpole, from the recently hatched (1) to the Adult Form (8).

cavity, like all fishes, they have true gills; but these, though not differing widely from those of other fishes living constantly in the water, are far from filling up the cavity, which is rather large; and this seems to contain not merely water but air as well."* It will be seen that this respiration is analogous to that of the land-crabs. And no better illustration is needed to show the identity in principle of the two kinds of respiration, aquatic and aërial.

Another class of air-breathing fishes, of which the *Anabas scandens*, or climbing perch of India, is a famous example, have an upward extension of the branchial cavity containing complicated foldings of the skull-bones covered with mucous membrane, which remains moist either by secretion or by condensation of moisture from the air. The *Anabas* lives in ponds which are liable in times of severe drought to

* Karl Semper's "Animal Life," p. 189.

become only mud or even entirely dry. It then travels over scorched and dusty ground in quest of water, and has been kept alive without water for six days. Tropical fresh-water fishes are commonly "able to survive droughts, living in semi-fluid mud or lying in a torpid state

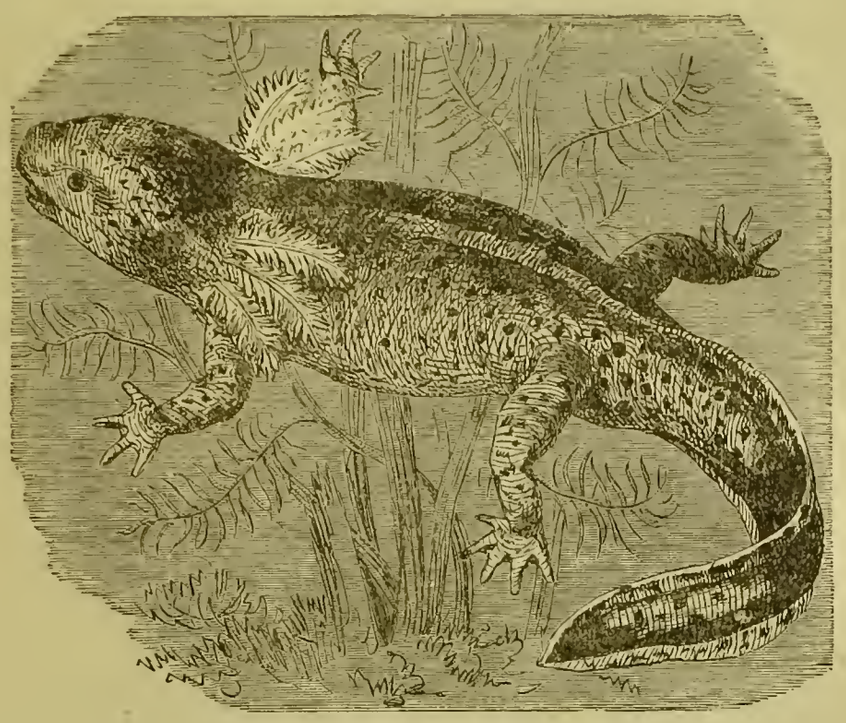


FIG. 4.—*Siredon pisciforme*, THE MEXICAN AXOLOTL.

below the hard-baked crust at the bottom of a tank, from which every drop of water has disappeared."*

The lung of vertebrates is an offset, "diverticulum," of the food-canal, and in some form is possessed by all classes of back-boned animals. In the fishes it is represented by the "swim-bladder," which is mechanical in function, serving to vary the specific gravity of the body. Yet in some species it has also a respiratory function. It is quite wanting in those fishes which, like the skate, grovel on the sea-bottom, and it is relatively large in the flying-fishes. In most adult

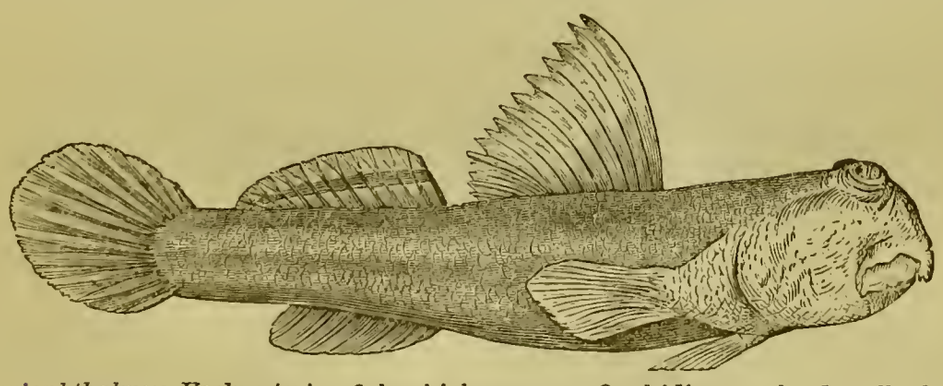


FIG. 5.—*Periophthalmus Koelreuteri*, a fish which pursues Onchidium—a land mollusk on the sea-shore. The large ventral fins serve for a forward leap. (After Semper.)

fishes the air-bladder is entirely closed, having no communication with any other organ; and the inclosed gas is obtained from the blood. This is largely nitrogen in fresh-water fishes, and oxygen in salt-

* Gunther's "Introduction to the Study of Fishes," p. 24.

water fishes; but the proportion of oxygen varies at different times, and is thought to act as a reserve against a time of need. This would be indirectly a respiratory function.

Certain fishes, the pike and eel for example, have the air-bladder communicating with the stomach, while the carp and many others have it in communication with the œsophagus. In the gar-pike, a cellular air-bladder communicates with the mouth by a trachea and glottis; and the mud-fishes have the same, not only resembling thus in structure the lungs of reptiles, but performing the same function. Thus we find in the single class of fishes a progression from a closed sac of mechanical function to a double lung like that of reptiles, and the point of communication rises from the stomach to the mouth.

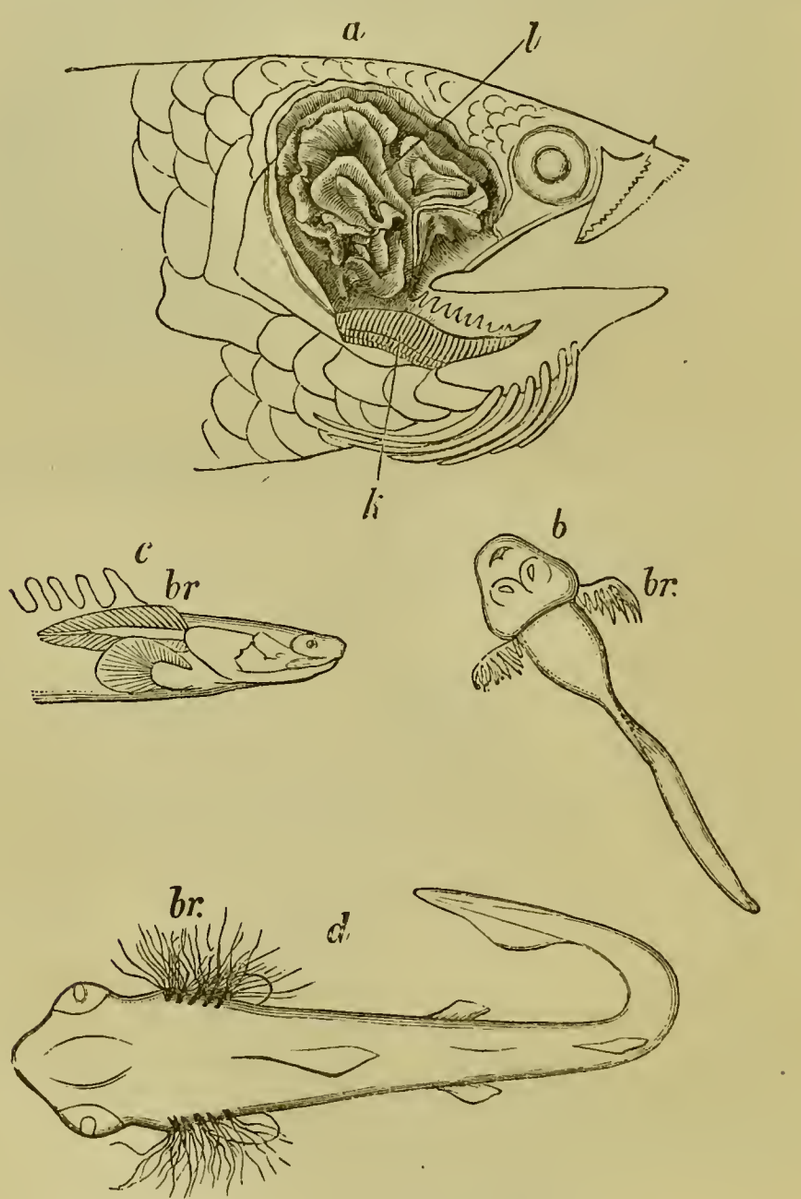


FIG. 6.—*a*, *Anabas scandens*; head, with *k* the gill-cavity laid open, and *l* the contiguous cavity containing the foliated labyrinthine structure. *b*, Tadpole; *c*, young Polypterus from the Nile; *d*, embryo of the shark. All these have external gills, *br*. (After Semper.)

All amphibians possess lungs in the adult state, but with varying degree of usefulness. Those having permanent gills may use the lungs very little, as the *Proteus* and *Menobranchus*, some of them perhaps not at all; while others, as the *Siren*, for instance, use them mainly. Other amphibians without gills may also quite dispense with the lungs,

using the skin instead. Even the frogs and toads can long survive the removal of their lungs. Many species of this class aid respiration by swallowing air. Frogs and toads force the air into their lungs by a swallowing action, made necessary by the absence of ribs ; and they can be suffocated, and turtles also, by holding their mouth open.

In the amphibians, we have a class of animals making use of four distinct means of respiration ; three of them—skin, gills, and lungs—in about equal degree. It might, therefore, be supposed that their respiration should be more active and the aëration of their blood more complete than in other vertebrates. Nevertheless, quite the reverse is the truth, for the reason that any function is better performed when localized or "specialized."

This latter fact is illustrated in the reptiles, which have a circulation as incomplete as the frog, with respiration more active, although

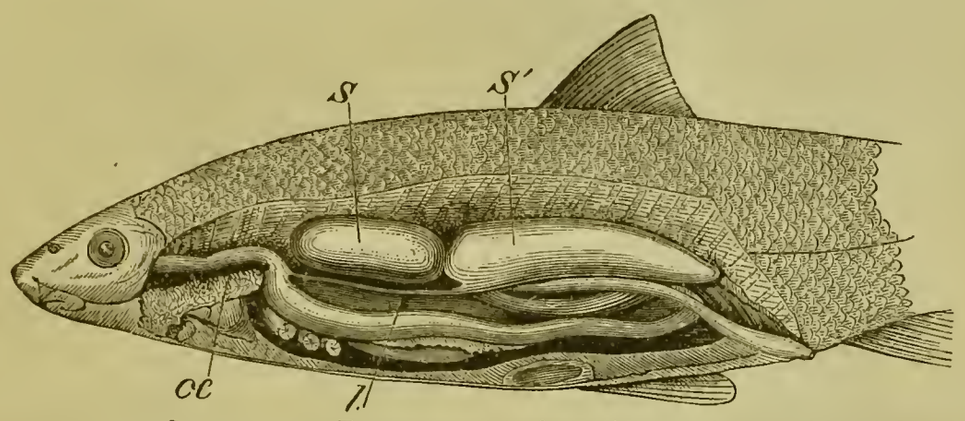


FIG. 7.—LONGITUDINAL SECTION OF A BLEAK. *s*, anterior; *s'*, posterior portion of the air-bladder ; *œ*, œsophagus ; *l*, air-passage of the air-bladder. (After Semper.)

possessing only lungs. These are, of course, better developed in the reptile, where they are large sacs, having the interior surface increased by foldings, producing *sacculi*. Serpents have the left lung undeveloped, the right one forming a long, cylindrical sac capable of holding a large amount of air. By this means water-snakes are rendered buoyant, and fitted for long submergence. The last fact is also true of turtles.

FIG. 8.—DIPNOI (*Lepidosiren annectens*), ONE OF THE MUD-FISHES, USING THE AIR-BLADDER AS A LUNG.

Lizards and crocodiles have two lungs, usually somewhat divided, and extending through the whole trunk. By their inflation the chameleon can give itself a plump appearance.

Reptiles have only a slight motion of the ribs, and are remarkable as a class for feebleness of respiration, considering that their lungs are

proportionately the largest among animals. In some species the skin is quite as active as the lungs, and the latter can be removed without causing immediate death.

The lungs of birds are less developed structurally than those of mammals, but are much larger. Connected with them in various parts of the body are air-sacs, especially in the abdomen and beneath the skin of the neck and wings. Except in water-birds, the hollow bones also contain air, and by their connection with the lungs respiration can be continued through an opening in the arm or thigh-bone, although the windpipe may be tied.

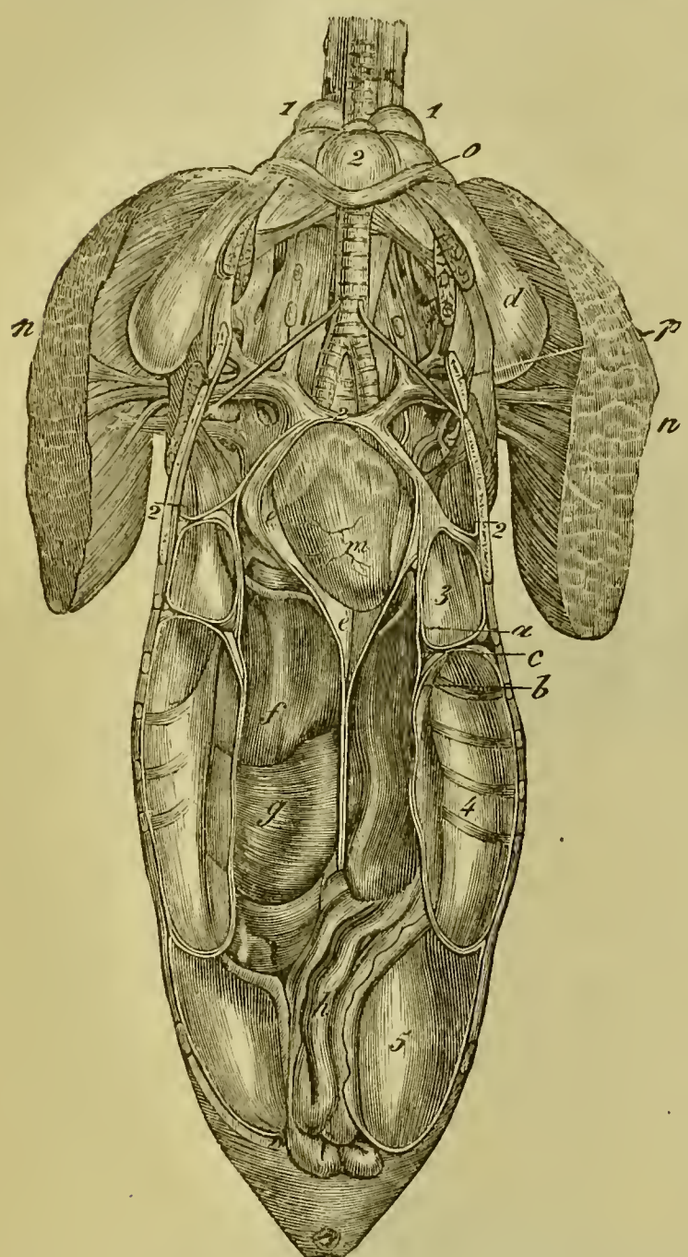


FIG. 9.—GENERAL VIEW OF THE AIR RESERVOIRS OF THE DUCK, OPENED INFERIORLY; ALSO THEIR RELATIONS WITH THE PRINCIPAL VISCERA OF THE TRUNK. 1, 1, anterior extremity of the cervical reservoirs; 2, thoracic reservoir; 3, anterior diaphragmatic reservoir; 4, posterior ditto; 5, abdominal reservoir.—*a*, membrane forming the anterior diaphragmatic reservoir; *b*, membrane forming the posterior ditto.—6, section of the thoraco-abdominal diaphragm.—*d*, subpectoral prolongation of the thoracic reservoir; *e*, pericardium; *f*, *f*, liver; *g*, gizzard; *h*, intestines; *m*, heart; *n*, *n*, section of the great pectoral muscle above its insertion into the humerus; *o*, anterior clavicle; *p*, posterior clavicle of the right side cut and turned outward. (From M. Sappey's work.)

The respiratory system is most developed in birds of powerful flight, and doubtless aids in rendering them buoyant. Perhaps the air-sacs beneath the wings assist in holding the latter outstretched; and it has been suggested that the sacs might serve as a cushion to protect those which suddenly dive into water after prey.

The blood-capillaries in the lungs of reptiles and amphibians are exposed to the air on one side only, while those of birds and mammals are arranged on a different and superior plan, being exposed on two opposite sides. Lungs of birds consist of an aggregation of distinct lobules or "lunglets." As the lungs are attached to the dorsal side of the chest, and the diaphragm is imperfect, expiration is effected by an active effort—by pulling the breast-bone nearer the spine, and so diminishing the cavity.

While reptiles can live in air too impure for mammals, birds will die in an atmosphere which to mammals is quite harmless. Birds bear

a relation to other vertebrates similar to that of insects among the invertebrates. They lead an insect-like existence; and their rapid respiration is effected not, as in mammals, by minute partitioning and subdivision of the lungs, but, as in insects, by extension and increase in capacity. And the air-cavities in the bones and tissues bring the air, as in insects, into effective contact with the capillaries of the system.

In mammals, respiration is quite restricted to the lungs, the skin performing in man only about one fiftieth part of the work. The lungs are less in proportionate bulk than those of reptiles and birds; but the lack of capacity is compensated by the minute subdivision of the cavity, giving immensely greater surface. The active carnivores possess the largest lungs.

The ultimate cells of the human lungs are from one two-hundredth to one seventieth of an inch in diameter, and in number are about six hundred million. Mammalian lungs are always partially filled with air, and only by great pressure can the air be sufficiently expelled from the lung-tissue to allow it to sink in water. This property has given the lungs the vulgar name of "lights."

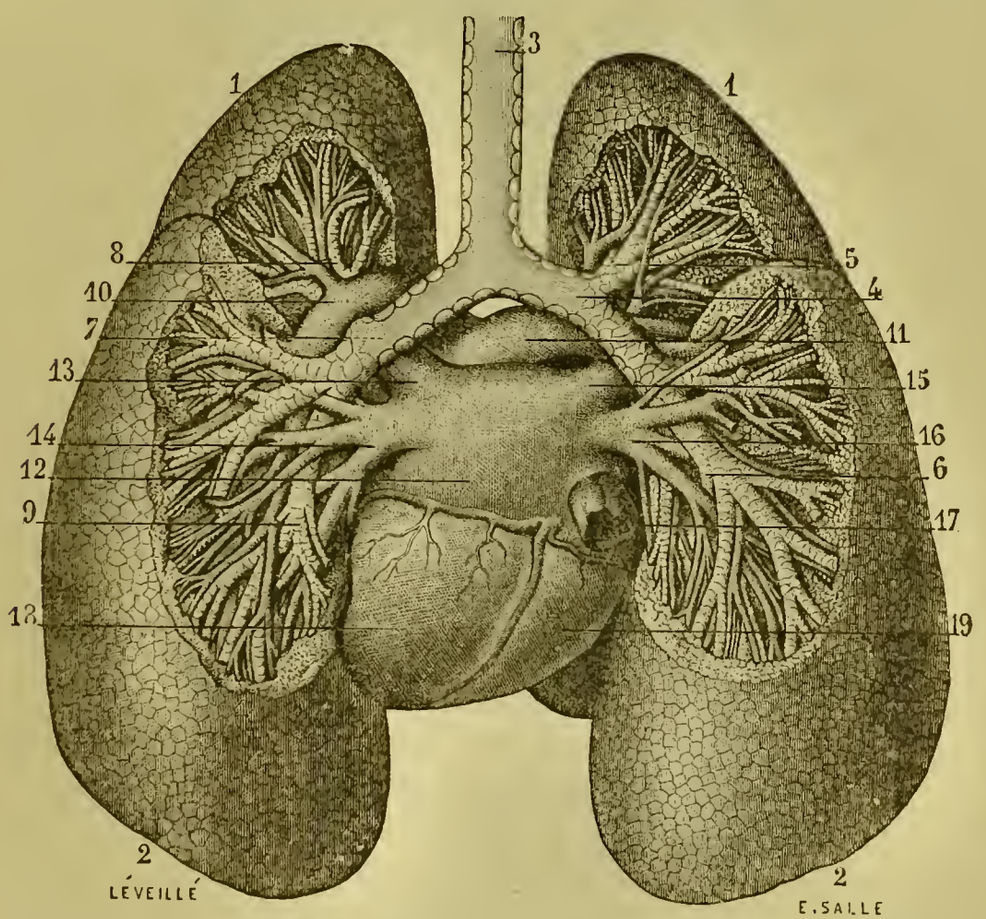


FIG. 10.—BRONCHI AND LUNGS OF MAN. (Sappey.) 1, 1, summit of the lungs; 2, 2, base of the lungs; 3, trachea; 4, right bronchus; 5, division to the upper lobe of the lung; 6, division to the lower lobe; 7, left bronchus; 8, division to the upper lobe; 9, division to the lower lobe; 10, left branch of the pulmonary artery; 11, right branch; 12, left auricle of the heart; 13, left superior pulmonary vein; 14, left inferior pulmonary vein; 15, right superior pulmonary vein; 16, right inferior pulmonary vein; 17, inferior vena cava; 18, left ventricle of the heart; 19, right ventricle.

That portion of the contained air which in life can not be expelled from the lungs is called *residual* air. The amount of air moved in ordinary breathing employs but a small part of the breathing capacity,

and is termed *tidal* air. Besides the residual air which can not be expelled, the lungs ordinarily contain a large quantity which can be exhaled by a forced expiration. This is known as *reserve* air. And, in addition to these three kinds, a large quantity can be inhaled by a forced inspiration, called *complemental* air.

In this can be seen a fine adaptation to the requirements of varying circumstances; for, if the breathing of mammals were normally at the full capacity, there would remain no provision for varying the rapidity of respiration according to temperature and exercise. Moreover, the residual air gives uniformity and constancy to the respiratory change of the blood, and prevents sudden variations in the kind, amount, and temperature of the air in the lung-cells, which would be injurious to the blood and to the delicate tissues. The change of the residual air is slowly effected by the physical process of diffusion between it and the reserve air. When this purifying change is not sufficiently rapid, we are impelled to take a "deep breath," and so wholly replace the reserve air.

The relative and the absolute amounts of each of the four kinds of respiratory air in the human lungs may be tabulated thus:

Vital Capacity	Complemental air (can be inhaled by effort)...	90–110 cubic inches.
	Tidal air (moved in ordinary breathing).....	20– 30 " "
	Reserve air (can be exhaled by effort).....	90–110 " "
		200–250 cubic inches.
Residual air (can never be exhaled)		100–130 " "
Total capacity of human lungs.....		300–380 cubic inches.

The breathing-pump of mammals may be compared to a conical box with movable sides and base. By contraction of the muscles attached to and connecting the ribs, the sides of the chest are moved upward and outward; while at the same time the diaphragm, forming the arched base of the chest, is depressed or flattened by its muscular contraction. Thus the greater muscular effort in ordinary breathing is used to enlarge the cavity of the thorax or chest, producing inspiration—not, as in birds, to diminish the cavity, producing expiration. In other words, the air is forced into mammalian lungs by atmospheric pressure when, through muscular effort, the chest enlarges; and the air is expelled simply by the elastic reaction of the lungs and chest.

The lungs are freely suspended by the windpipe, and are distended by the atmospheric pressure in opposition to their elasticity. Consequently, an opening in the walls of the thorax is liable to produce suffocation, by giving the air a more direct and easy route to the vacuum of the chest than through the trachea and lungs.

A delicate membrane called the *pleura* closely invests the lungs, and is then reflected to line the cavity of the thorax. By the secretion of a serous fluid, it prevents friction, which would otherwise result from the constant movement.

A rude apparatus to illustrate the mechanism of breathing in mammals is easily made by suspending the lungs of some small animal in a glass bell-jar closed below by an elastic membrane—a sheet of rubber, for instance—the only access for air to the interior being through the windpipe. Then the forced enlargement of the cavity, by pulling down the membrane, causes the inflation of the lungs. This apparatus is deficient in mobility of the walls.

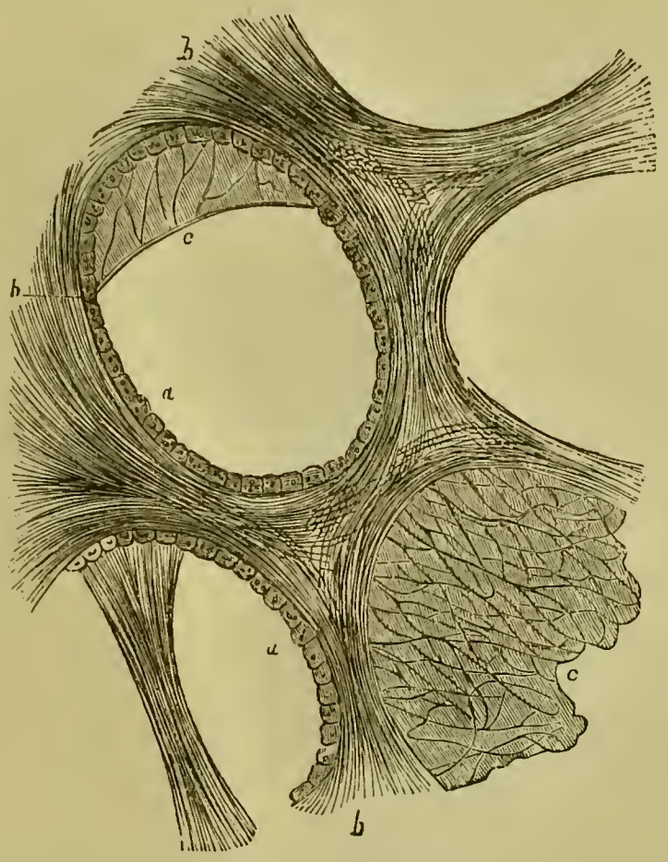


FIG. 11.—AIR-CELLS OF LUNG, WITH INTERVENING TISSUES. *a*, epithelium; *b*, elastic trabeculæ; *c*, membranous wall, with fine elastic fibers.

The rapidity of the respiratory movements in man is about one inspiration to four heart-beats, or fifteen to twenty-five per minute; greatly varying, however, according to age, sex, and circumstances. In animals with high temperature, breathing is much faster, becoming almost a tremor in birds. In the whale, on the contrary, breathing is suspended while the animal is under water; it being provided with reservoirs of pure blood. When the latter is exhausted, the creature comes to the surface and puffs and "blows" to obtain air and refill the reservoirs.

The difference in color of the blood of vertebrates is chiefly due to the varying amount of oxygen in chemical combination with the hæmoglobin of the red corpuscles—the brightness of color being proportionate to the oxygen. An essential part of the hæmoglobin is iron; and it has been supposed that the change in color is due to a chemical change from a ferrous to a ferric salt. But this simple and plausible explanation is now denied by eminent physiologists, who, however, admit that the iron has some essential but unknown influence. A

minor cause of the darker color of the blood is the swelling of the corpuscles by absorption of carbonic acid.

The corpuscles are the oxygen-carriers, seizing the oxygen in the lungs and conveying it to the tissues, where it unites with the carbon

FIG. 12.—BRONCHIAL TUBE, WITH ITS BRONCHULES AND ULTIMATE RAMIFICATIONS (natural size).

and hydrogen. The corpuscles also convey carbonic acid to the lungs, but they divide this labor with the serum.

In large quantity, carbonic acid acts as a narcotic poison ; for, on account of its superior attraction for the hæmoglobin, it replaces and excludes the oxygen. Other gases, as nitric oxide, have the same effect. Nitrogen, on the other hand, is entirely negative in its effect on the blood, and consequently serves to dilute the oxygen of the atmosphere, without injury to animal life.

More oxygen is inhaled than is exhaled as a component of carbonic acid. The extra amount doubtless unites with hydrogen to form a portion of the exhaled water, and to produce sulphuric and phosphoric acids.

The human lungs exhale, in twenty-four hours, about two pounds of carbonic acid. This is the product of the burning of nine ounces of carbon. As giving some idea of the forces within the body, it is interesting to know that the combustion of nine ounces of carbon liberates over six million foot-pounds of energy. This is equivalent to

more than one eighth of a horse-power acting continuously for the twenty-four hours; or it equals one hundred and eighty-two horse-powers working for one minute.

But the combustion of carbon does not include the total oxidation within the body; for, in less degree, hydrogen, sulphur, phosphorus, and iron, are also burned.

A large part of the energy thus produced is utilized in the unceasing labor of the circulation and the respiration. In a year the number of respirations is, in most persons, over nine million; and one hundred and twenty-five thousand cubic feet of air carried through the lungs purifies at least five thousand tons of blood. Yet, so perfect is the apparatus, that we are almost unconscious of its action, unless warned by disease, or the delicate lining of the air-tubes is irritated by some foreign matter.

HAS SCIENCE YET FOUND A NEW BASIS FOR MORALITY?

By Professor GOLDWIN SMITH.

TO ask whether Science has yet found a new basis for morality, or even to answer that question in the negative, is a widely different thing from saying that morality can not exist without religion. It is still more widely different, if possible, from imputing immoral tendencies to science. No sane being doubts that the tendency of truth of every kind is moral, or that the tendency of falsehood of every kind, if persisted in, is immoral. But we are not bound to accept at once as science everything that is tendered as such by scientific men on subjects with which, perhaps, they have not long been familiar, and at a time when the excitement created by great discoveries is sure to give birth to a certain proportion of chimeras. If we were, we should have to accept the theory of the automaton man, which has been pressed upon us by the very highest scientific authority with a confidence bordering on the despotic, and that of the "citizen atoms," which, according to Haeckel, while diffused through space, concerted among themselves the structure of the world. Nor in any case can we allow ourselves to be hurried headlong by the current of new opinion into negative any more than into positive conclusions; above all, when the abjuration of a belief involves not merely a change in treatises of philosophy, but the greatest practical consequences, such as the abolition of religion. For abolished religion ought to be, and must be, as soon as it is proved to be founded on falsehood; the proposal of freethinkers, like Renan, to keep up the system as the means of restraining the vulgar and protecting the refined enjoyments of the cultivated, being no less shallow and, in an age

of educated artisans, impracticable than it is repugnant to morality. We may accept with admiration and gratitude Darwin's scientific discoveries without feeling ourselves obliged to draw from them inferences which the discoverer himself has not drawn. We may recognize the breaches made by science, history, and criticism in the evidences not only of Christianity, but of natural religion; we may admit with sadness that the world is at present left without any positive proof, in a producible form, of articles of belief deemed but a few years ago as indisputable as they were fundamental; yet we may decline at once to pronounce that the religious sentiment in man is devoid of meaning, and that the evidences are absolutely incapable of rational reconstruction. Doubt, frankly avowed, and coupled with a resolve under all perplexities to be patient and see what the future of inquiry may have in store, is the attitude, as I am persuaded, of many men of science in whose characters caution and reverence have a place, as well as of many thoughtful and cultivated men of the world.*

* I take this, the first available opportunity, of saying that a paper professing to be a critique of three articles of mine—two in "Macmillan" and one in the "Atlantic Monthly"—on subjects akin to that of the present paper, by Miss Louisa Bevington, which appeared in the "Fortnightly Review" of August last, was as complete a misrepresentation of the purport of those articles, of their spirit, and, above all, of the attitude of their writer toward science and scientific men, as angry prejudice could produce. The most recent of the three articles attacked had appeared in the "Atlantic Monthly" a year and nine months before this sudden outpouring of the vials of philosophic wrath, the immediate motive for which it is difficult to divine. The nature of my offense, however, is apparent enough. In her exordium Miss Bevington discloses her intention of suppressing what she is pleased to term the "noisy literature" of people like me, who accept Darwin's scientific discoveries and yet refuse, as at present advised, to draw inferences which, as has been said in the text, Darwin himself has not drawn, and which he has given us no reason for believing that he is disposed to draw. She hardly displays the spirit of the philosophy of which she is the devotee. The highly evolved ought to have patience while inferior creatures are going through the necessary stages of their evolution. I am charged with "reading evolutionism into the views of persons not commonly credited with paramount scientific authority, for the purpose of taking it out again ethically besmirched and reeking with the blood of the weaker peoples." If the charge were true, it would justify any amount of denunciation and almost any mixture of metaphors. But the passages of my three articles on which Miss Bevington founds it (and which she represents as the main purport and substance of the articles, though in truth they are of the most cursory kind and comprise in all only three or four sentences) do not relate to evolution at all: they relate to the doctrine of the moral inequality of races and their different claims to legal protection, put forth by Professor Tyndall at the time of the Jamaica affair. Professor Tyndall, not Dr. Darwin, is the "eminent man" to whom I allude, as I have thought that anybody who remembered the Jamaica controversy would have known. To the scientific doctrine of evolution I gave the frankest adhesion, acknowledging "that it was unspeakably momentous, and that great was the debt of gratitude due to its illustrious authors." This Miss Bevington does not quote, but she satisfies her sense of justice by alluding to the passage as 'certain ethical admissions favorable rather than not to the evolution hypothesis." I am incapable of such folly as ascribing immoral consequences to any genuine discovery of science. Science, in combination with historical philosophy and literary criticism, is breaking up religious beliefs; and the break-up of religious beliefs is attended, as experience seems to show, with dan-

He must be a scientific optimist, indeed, who refuses to admit that society has come to a critical juncture. That the rule of human life may ultimately be placed on grounds wholly independent of religion is a possibility which, once more, is not here disputed, though it is reasonable to wait for the demonstration of experience. But the interval may be one of serious disturbance. To use an undignified comparison, the crustacean may be sure to get another shell, but he will be soft in the mean time. It seems impossible to question the fact that the morality of the mass of the people, at all events, has hitherto been greatly bound up with their religious belief. Ecclesiastical dogma may have had no effect on them; perhaps it has had worse than none, inasmuch as it has put forms in place of moral realities—an evil equally great

ger to popular morality. To say this, and to illustrate it historically, as I did in the "Atlantic," is a very different thing from saying that science is immoral. The inroads made, not more by science than by the other agencies and influences enumerated, on the evidences of religion have been recognized by me in the article on "The Prospect of a Moral Interregnum" with a freedom which must, I should think, have shown anybody not blinded by philosophical antipathy that it would be absurdly unjust to identify me with reactionary and obscurantist orthodoxy. My position, frankly avowed in all the articles, is that of doubt. I think I may venture to say that no one who is acquainted with me, and knows what my course has been on university questions, and questions of education generally, will deny my loyalty to genuine science. Instead of disparaging the morality of scientific men I have expressly recognized their moral superiority as a class, only pointing out that we can not reason from their case to that of the multitude. To those of the number who served on the Jamaica Committee I have paid the best tribute in my power by saying that they were "among the foremost champions of humanity on that occasion," as Miss Bevington finds herself compelled with very manifest reluctance to admit. There can be no harm in saying that the passage was inserted in the second "Macmillan" article to satisfy Mr. Herbert Spencer, who, as I learned in a conversation with him, had misconstrued, strangely as it appeared to me, a passage in the first. I assured him that I felt, and had always expressed in public and private, the greatest admiration and gratitude for the noble conduct of Mr. Huxley and others of that school in the Jamaica business, and that, if there was any possibility of misapprehension on the subject, I would take the first opportunity of removing it. In what respect I failed to fulfill my promise I am at a loss to see. I could not say that science was the main support of the movement in the country; the main support of this, as of the anti-slavery movement, Miss Bevington would have found, if she had carried her statistical researches a little further, was the Christianity of the Free Churches. What a political clergy might do from political motives could in no way affect religion. That in the case even of the men of science, a philanthropy, the offspring of the Christianity in which we have all been nurtured, was likely to be the impelling influence rather than anthropology, was an opinion for which I had my reasons, and which at all events was not offensive. In the interest of scientific truth Miss Bevington does not shrink from affecting to believe that I am assailing science when I deprecate the invasion of Afghanistan in quest of "a scientific frontier." Nor does she shrink from making up a quotation out of two passages, one of which is taken from an article in "Macmillan," the other from an article in the "Atlantic Monthly," and which, if they relate to the same controversy, do not relate to the same persons. The tone of the article in the "Fortnightly" was such as could hardly fail to act as a warning against too ready an acceptance of its statements. But anything published in so eminent a journal goes forth with some authority, and the idea that a large circle of readers might be led utterly to misconceive my feelings toward science and men of science gave me, I confess, some pain.

whether the forms are articles in irrational creeds or outward observances. But can it be maintained that the belief in an All-seeing Eye —in infallible, inflexible, and all-powerful justice—in a sure reward for well-doing and a sure retribution for evil-doing—has been without influence on the conduct of the mass of mankind, or that its departure is likely to be attended by no consequences of importance? There are two miners, say, by themselves, and far from human eye, in the wilds of the far West: one has found a rich nugget, the other has toiled and found nothing. What hinders the man who has found nothing, if he is the stronger or the better armed, from slaying his mate as he would a buffalo, and taking the gold? Surely, in part at least, the feeling, drawn from the Christian society in which his youth was passed, that what is not seen by man is seen by God, and that, though the victim himself may be weak and defenseless, irresistible power is on his side. I say in part only; I say at present only; and, once more, I do not prejudge the question as to the possible appearance of an independent and self-sustaining morality in the future. We dwell too exclusively on the restraining principle. Who can doubt that religion has, as a matter of fact, largely impelled to virtue; that it has formed characters at once of great force and of great beneficence; that it has sustained philanthropy and social progress? Who can doubt that many good and noble works have been, and are still being performed, from love of God and from a love of man which is inspired by belief in our common relations to God? Who can doubt that heroes and reformers have been led to face peril, to risk their lives in the service of their kind, by the conviction that they were doing the Divine will, and that while they were doing it they would be in the Divine keeping? Would it be so easy even to man a life-boat if all the ideas and all the hopes which center in the village church were taken out of the seaman's heart? Go to the beach: tell the men that if they sink there will be an end for ever of them, and of their connections with those whom they love; are you sure that they will not be rather less ready to take an oar?

Hundreds of thousands have suffered death for their religion. Is it conceivable that the belief for which they died can have had no influence on their lives? Is it conceivable that the influence can have been confined to the martyrs? Is not Christendom almost coextensive with moral civilization? And does not the whole face of Christendom —do not its literature, its art, its architecture, show that religion has been its soul? So, at least, thought that eminent agnostic who pronounced the eighteen centuries of Christianity a retrogression from the happy and scientific age of Tiberius, and by that strange burst of antitheistic frenzy showed that we may have to be on our guard against a fanaticism of hostility to religion as well as against a fanaticism of religion.

The opinion of those who are confident that no moral disturbance

is coming, but, on the contrary, a great and universal improvement in morality, might have more weight with us if we were sure that their eyes were turned in the right direction. But their observation is apt to be limited, or too much directed to the circle of scientific men around them. Scientific men are pretty sure to be above the average in point of morality ; they have dedicated themselves to a high calling, they are elevated by its pursuits, they are free from the more violent passions, and removed from the coarser temptations. For the signs of change we must look rather to the scenes on which men struggle for wealth or power, and the social regions in which the common vices prevail. We must look to the multitudes, who, being now told that they have no hope beyond this world, are apparently making up their minds to have as large a share of the goods and pleasures of this world as their force will give them. Communism, intransigentism, and nihilism are not well represented in scientific reunions. They who sat round the dinner-table of Helvetius, and congratulated each other on the coming of an age of reason and happiness, were the destined victims, not the workers, of the guillotine.

Moreover, as has been said before, the intellectual world, at all events, is still in the twilight of religion. That expression is, indeed, too weak in the case of the positivists, who, not only call themselves a church, but make good their claim to the title by sermons which would do the highest honor to any pulpit, and, though they prefer the name of humanity to that of God, must be really worshiping a deity, not an abstract term, which would be as deaf to prayers or praise as a stock or a stone. An abstract term, in truth, would be rather less susceptible of adoration than that which, like a stock or a stone, has at all events a real existence. But even the man of intellect who rejects all churches and all worship has still sentiments, hopes, and a conscience formed under the influence of Christianity. The same thing is indicated by the repudiation of the name atheist, and the adoption of the strange term agnostic. Blank absence of belief or inclination either way is probably an impossible frame of mind ; in nine cases out of ten, when a man calls himself an agnostic, he most likely means that he retains his belief in the existence of a God, though without being able to present the proof distinctly to himself. The very term law, which physical science continues to use, though we can physically be cognizant of nothing beyond general facts, has a theistic significance, and carries with it a certain sense of religious elevation and comfort. Small probably, as yet, is the number of those who have fairly looked in the face blind force and annihilation.

But to the present question. An heroic physician—we remember to have come across the case in some Italian history—finding that a new and mysterious plague is ravaging his city, devotes himself to the preservation of his fellow-citizens, shuts himself up with a subject, takes his observations, consigns them to writing, and, feeling the poison

in his own veins, goes calmly to the hospital to die. On the other hand, a man, between whom and a great fortune there stands a single life, takes that life in such a way as to escape suspicion, gets possession of the fortune, and, instead of a life of drudgery to which he would otherwise have been doomed, passes his days in the healthy development of all his faculties, in the enjoyment of every pleasure, intellectual and social, as well as physical, amid the troops of friends and grateful dependents with which his hospitality and munificence surround him, and, after an existence prolonged by comfort, ease, and immunity from care, dies universally honored and lamented. Why is the first man happy, and the second miserable? Theism, on his own hypothesis, has an answer ready. What is the answer of agnostic science? We must prefix an epithet, because without it a distinction drawn between science and theism begs the question. A rational theist maintains that theism is science.

We are likely to find the answer, if anywhere, in the "Data of Ethics," by Mr. Herbert Spencer—a book belonging to a series which has earned for its author, from Darwin himself, the title of "our great philosopher"; and which every one, whether he accepts its general conclusions or not, will allow to exhibit powers of acute criticism, and to be written in a most lucid and attractive style.

Mr. Spencer commences, as might have been expected, not with humanity, but with the mollusks, and treats men simply as the last (he says the highest, but we have a *caveat* to enter against that phrase) of the evolutionary series. His tests of right and wrong in the actions of the most evolved of animals, as in the case of the least evolved, are pleasure and pain—pleasure denoting that the action is favorable, pain that it is unfavorable, to the vitality of the organism. His "supreme end" is "increased duration," together, if we understand his phraseology rightly, with increased intensity, "of life." An authoritative conscience, duty, virtue, obligation, principle, and rectitude of motive, no more enter into his definitions, or form parts of his system, than does the religious sanction. Of that which constitutes moral beauty, he has no word. Actions of a kind purely pleasant are absolutely right. The highest instance of right conduct is a mother suckling her child, because "there is at once to the mother gratification, and to the child satisfaction of appetite, a satisfaction which accompanies furtherance of life, growth, and increasing enjoyment." That the action is a mere performance of a function of nature, involving the exertion of no high quality, does not lower its place in the scale. Conduct, even the noblest and most heroic, which has any concomitant of pain or any painful consequence, is, to that extent, wrong, and the highest claim to be made for such conduct is that it is the least wrong which under the conditions is possible. We need not shrink from the hypothesis, or even commit ourselves to the rejection of it. Possibly the conclusion ultimately reached may be that man is nothing but the highest

mammal, and in that case the hypothesis will be true. The present question is, whether it affords a new basis for morality.

Applying the tests, then, to the cases mentioned, we find that the action of the Italian physician is at least partly wrong: it gives him pain, and, instead of prolonging or intensifying, terminates his own life; it is ethically inferior to that of a Caffre woman suckling her child. On the other hand, the action of the murderer is at least partly right: to himself it is unquestionably productive of a great deal of pleasure, and, by releasing him from toil which might have been injurious to his health, it very likely prolongs his life, and certainly intensifies his enjoyment. The benefit extends to his family, and to all those who will profit by his judicious and liberal use of the wealth which comes into his hands. If the murdered man was a fool, a niggard, or a selfish voluptuary, who would have made no use of his riches or have used them ill, it really may be said that all the visible and calculable consequences of the action are good. One human life, indeed, is sacrificed, but from Mr. Spencer's point of view nothing can be said about the indefeasible sacredness of human life. Sacredness in general, and the sacredness of human life in particular, are religious conceptions, and as such have no place in his philosophy. Man may be "the highest of mammals," but is there any assignable reason why you should not put him, as well as any other inconvenient mammal, out of your way? When a stag gores his fellow-stag to death, that he may have exclusive possession of the does, we do not think that he does anything wrong, but, on the contrary, regard his action as a striking instance of the law of natural selection carried into effect through the struggle for existence. Mr. Spencer may say, and does say, that a few æons hence, by the progress of evolution, or, to use his own formula, by "our advance toward heterogeneity," matters will be so adjusted, and men will have become so sensible of altruistic pleasure, that it will be not less disagreeable to you to kill your neighbor than to be killed yourself. But the murderer, if this is pressed upon him, will say: "A few æons hence I shall be out of the way; I will do that which, as it brings me present pleasure, with increased duration and intensity of life, is, as far as I am concerned, right." It is not very apparent what answer could be made. We are in quest, be it observed, at present, not of a moral horoscope of humanity, but of motives which, by making the men of our day—not the Herbert Spencers, but the ordinary men—do good and abstain from evil, shall save the world from a moral interregnum.

Pleasure is relative to the organism. There is no such thing as a type or ideal of perfection. This also Mr. Spencer lays down with the same distinctness with which he lays it down that pleasure and pain are the sole and universal tests of right and wrong in conduct. The master will perhaps be somewhat startled by seeing his twofold doctrine developed under the fearless hands of one of his disciples.

Dr. Van Buren Denslow, the author of "Modern Thinkers," is one of the Americans who, sometimes with more of mother-wit than of erudition, are grappling vigorously, and in a practical spirit, with the great problems of the age. His work is introduced with a preface by Mr. Robert Ingersoll, the foremost teacher of agnosticism on that continent. The doctor is a profound admirer of Mr. Spencer, whom he depicts, in grandiose language, as assisting in the majesty of science at the birth of worlds. But he wants to push the agnostic principle to its logical conclusion, which, according to him, is, that there is no such thing as a moral law, irrespectively of the will of the strongest:

It is generally believed to be moral to tell the truth, and immoral to lie. And yet it would be difficult to prove that Nature prefers the true to the false. Everywhere she makes the false impression first, and only after years, or thousands of years, do we become able to detect her in her lies. . . . Nature endows almost every animal with the faculty of deceit in order to aid it in escaping from the brute force of its superiors. Why, then, should not man be endowed with the faculty of lying, when it is to his interest to appear wise concerning matters of which he is ignorant? Lying is often a refuge to the weak, a stepping-stone to power, a ground of reverence toward those who live by getting credit for knowing what they do not know. No one doubts that it is right for the maternal partridge to feign lameness, a broken wing or leg, in order to conceal her young in flight, by causing the pursuer to suppose he can more easily catch her than her offspring. From whence, then, in nature, do we derive the fact that a human being may not properly tell an untruth with the same motive? Our early histories, sciences, poetries, and theologies are all false, yet they comprehend by far the major part of human thought. Priesthoods have ruled the world by deceiving our tender souls, and yet they command our most enduring reverence. Where, then, do we discover that any law of universal nature prefers truth to falsehood, any more than oxygen to nitrogen, or alkalies to salts? So habituated have we become to assume that truth-telling is a virtue, that nothing is more difficult than to tell how we came to assume it; nor is it easy of proof that it is a virtue in an unrestricted sense. What would be thought of the military strategist who made no feints, of the advertisement that contained no lie, of the business-man whose polite suavity covered no falsehood?

Inasmuch as all moral rules are in the first instance impressed by the strong, the dominant, the matured, and the successful upon the weak, the crouching, the infantile, and the servile, it would not be strange if a close analysis and a minute historical research should concur in proving that all moral rules are doctrines established by the strong for the government of the weak. It is invariably the strong who require the weak to tell the truth, and always to promote some interest of the strong. . . .

"Thou shalt not steal," is a moral precept invented by the strong, the matured, the successful, and by them impressed upon the weak, the infantile, and the failures in life's struggle, as all criminals are. For nowhere in the world has the sign ever been blazoned on the shop-doors of a successful business-man, "Closed, because the proprietor prefers crime to industry." Universal society might be pictured, for the illustration of this feature of the moral code, as consisting of two sets of swine, one of which is in the clover, and the other is out. The swine that are in the clover grunt, "Thou shalt not steal—put up the bars." The swine that are out of the clover grunt, "Did you make the clover?—let

down the bars." "Thou shalt not steal," is a maxim impressed by property-holders upon non-property-holders. It is not only conceivable, but it is absolute verity, that a sufficient deprivation of property, and force, and delicacy of temptation, would compel every one who utters it to steal, if he could get an opportunity. In a philosophic sense, therefore, it is not a universal, but a class, law; its prevalence and obedience indicate that the property-holders rule society, which is itself an index of advance toward civilization. No one would say that, if a lion lay gorged with his excessive feast amid the scattered carcass of a deer, and a jaguar or a hyena stealthily bore away a haunch thereof, the act of the hyena was less virtuous than that of the lion. How does the case of two bushmen, between whom the same incident occurs, differ from that of the two quadrupeds? Each is doing that which tends in the highest degree to his own preservation, and it may be assumed that the party against whom the spoliation is committed is not injured at all by it. Among many savage tribes theft is taught as a virtue, and detection is punished as a crime. . . . Having control of the forces of society, the strong can always legislate, or order, or wheedle, or preach, or assume other people's money and land out of their possession into their own, by methods which are not known as stealing, since, instead of violating the law, they inspire and create the law. But, if the under dog in the social fight runs away with a bone in violation of superior force, the top dog runs after him bellowing, "Thou shalt not steal," and all the other top dogs unite in bellowing, "This is divine law, and not dog law"; the verdict of the top dog, so far as law, religion, and other forms of brute force are concerned, settles the question. But philosophy will see in this contest of antagonistic forces a mere play of opposing elements, in which larceny is an incident of social weakness and unfitness to survive, just as debility and leprosy are; and would as soon assume a divine command, "Thou shalt not break out in boils and sores," to the weakling or leper, as one of "Thou shalt not steal," to the failing struggler for subsistence. So far as the irresistible promptings of nature may be said to constitute a divine law, there are really two laws. The law to him who will be injured by stealing is, "Thou shalt not steal," meaning thereby, "Thou shalt not suffer another to steal from you." The law to him who can not survive without stealing is simply, "Thou shalt, in stealing, avoid being detected."

So the laws forbidding unchastity were framed by those who, in the earlier periods of civilization, could afford to own women, for the protection of their property rights in them, against the poor who could not. . . . We do not mean, by this course of reasoning, to imply that the strong in society can, or ought to, be governed by the weak: that is neither possible, nor, if possible, would it be any improvement. We only assert that moral precepts are largely the selfish maxims expressive of the will of the ruling forces in society, those who have health, wealth, knowledge, and power, and are designed wholly for their own protection and the maintenance of their power. They represent the view of the winning side, in the struggle for subsistence, while the true interior law of nature would represent a varying combat in which two laws would appear, viz., that known as the moral or majority law, and that known as the immoral or minority law, which commands a violation of the other.

This is strong doctrine, and the passage seemed worth extracting at length. It is curious, both as a specimen of the practical tendencies of a certain school of thought, and as a reply to the historical skepticism which refuses to believe that the teaching of the sophists really

was what it is represented to have been by Socrates and Plato. It would also seem to be a pretty conclusive answer to those who deride the apprehension of a moral interregnum, and feel confident that society is going to sail, without interruption or disturbance of its rule of conduct, out of the zone of theistic into that of scientific morality. It appears that between one state and the other there may be an interval in which the question will be not between the moral and the immoral, but between the top and the under dog.

The Marquis of Steyne is an organism, and, like all other organisms, so long as he succeeds in maintaining himself against competing organisms, is able to make good his title to existence under the law of natural selection. He has his pleasures: they are not those of a St. Paul, or a Shakespeare, or a Wilberforce, but they are his. They make him happy, according to the only measure of happiness which he can conceive; and if he is cautious, as a sagacious voluptuary will be, they need not diminish his vitality, they may even increase it both in duration and intensity, though they may play havoc with the welfare of a number of victims and dependents. He may successively seduce a score of women without bad consequences to himself. Why is he doing wrong? In the name of what do you peremptorily summon him to return to the path of virtue? In the name of altruistic pleasure? He happens to be one of those organisms which are not capable of it. In the name of a state of society which is to come into existence long after he has moldered to dust in the family mausoleum of the Gaunts? His reply will furnish the anthropologist with a fine illustration of the faculty of facial expression. Suppose you could induce him to try a course of virtue, or of altruism, if the term is more scientific, what in his case would be the practical result? Would it not be a painful conflict between passion and conscience, or perhaps, in the terms of the evolutionary philosophy, between presented sensations on the one hand, and represented or re-represented sensations on the other? Is it not probable that he would end his days before that conflict had been brought to a close? Its fruits, however imperfect, would, of course, be both happy and precious in the estimation of theism; but in the estimation of the philosophy embodied in the "Data of Ethics," what could they be but pleasure, unquestionable pleasure, lost, and pain, pain of a very distressing kind, incurred? And so with other organisms, which, as Dr. Van Buren Denslow would say, are pursuing their peculiar and congenial though conventionally reprobated walks of life. The assassin, the robber, and the sharper have their status in nature, as well as any other members of the predatory tribes. It is possible that by the gradual triumph of industry over militarism, and the general progress of evolution, those changes which Mr. Spencer confidently predicts may be brought about. The wolf may become as the lamb, and may even in the general competition for altruistic pleasures tenderly conjure the lamb to eat him. At present he is a

wolf—a wolf with two legs it may be, and with the other physiological attributes of the highest of the mammals—yet as much at liberty as the lowest of the mammals to gratify his appetites so long as he does not eat any one who will disagree with him.

The author of the "Data of Ethics" discusses, in three lively and interesting chapters, altruism and its relations to egoism. But Dr. Van Buren Denslow flouts all this as "theological," and wonders that his sage should have allowed himself to be so much affected by the atmosphere of modern Christianity. The doctor hits the nail hard as usual, and there seems reason to suspect that he hits it on the head. "Thou shalt love thy neighbor as thyself," is commonly cited as the precept of the Gospel. But the full commandment is, "Thou shalt love the Lord thy God with all thy heart, and thy neighbor as thyself." Supposing the theistic hypothesis to be true, and the communion of the Christian Church to represent a reality, to love one's neighbor as one's self is rational; if the two are members of each other, each in loving the other loves himself, and there is no need of any elaborate comparison or arbitration. But on any other hypothesis it seems difficult to press the claims of altrusim on an egoistic organism. You must alter the organism, or wait till it is eliminated by evolution. If a man is selfish, his pleasures will be selfish ; and there, so far as we can see, according to the philosophy of the "Data of Ethics," is an end of the question.

Hear once more Dr. Van Buren Denslow :

> The unphilosophical element in Herbert Spencer's scheme is its dogmatical assumption that there is a moral law, philosophically deducible by argument from the facts of nature; that this moral law is unique and single, not dual, though all the forces of nature whose study is to lead up to the knowledge of this law are dual and not single; that while at some points it may not yet be clearly definable, yet all the facts indicate both its existence and its philosophical deducibility from nature. On this point he says, p. 282: "For reasons already pointed out, a code of perfect personal conduct can never be made definite. Many forms of life, diverging from one another in considerable degrees, may be so carried on in society as entirely to fulfill the conditions of harmonious co-operation. And if various types of men, adapted to various types of activities, may thus lead lives that are severally complete after their kinds, no specific statement of the activities universally required for personal well-being is possible. But though the particular requirements to be fulfilled for perfect individual well-being, must vary, along with variations in the material conditions of each society, certain general requirements have to be fulfilled by the individuals of all societies. . . . Perfection of individual life hence implies certain modes of action which are approximately alike in all cases, and which therefore become part of the subject-matter of ethics. That it is possible to reduce even this restricted part to scientific definiteness, can scarcely be said. But ethical requirements can here be to such extent affiliated upon physical necessities as to give them a partially scientific character. . . . That it will ever be practicable to lay down precise rules for private conduct in conformity with such requirements, may be doubted. But the function of absolute ethics in relation to private conduct will have been

discharged when it has produced the warrant for its requirements as generally expressed [i. e., that the individual should so promote his own pleasure as not to mar the pleasure of others]; when it has shown the imperativeness of obedience to them; and when it has thus taught the need for deliberately considering whether the conduct fulfills them as well as may be."

While Spencer gives away reluctantly nearly his whole position here (for of what value is an ethical system which can shed no light on the path of private duty?), yet the small portion he retains is retained unjustly, and must be surrendered. An ethical system which boils down into an exhortation to all men to promote their own interests has no ethical quality left in it; for, as we have seen, the mere doing of that which is clearly essential to self-preservation pertains to business and not to morals; since, to have a moral quality, an act must raise the question, Is it right? which mere attention to business does not raise any more than the flight of birds, the falling of water, or the explosion of gases.

The nearest thing to an authoritative and universal rule which we get in the "Data of Ethics" is the assertion that "the life of the social organism must, as a rule, rank above the lives of its units." Supposing even that society is in any but a figurative sense an organism with a life of its own distinct from those of its members, this canon, as it stands in Mr. Spencer's pages, appears to be almost as much a dogma and as little supported by demonstration as anything in the Athanasian Creed. Prove to a man, if you can, that to enjoy his own pleasure he must avoid interfering with the pleasure of others, obtain the co-operation of his fellows, and pay a certain tribute to the interests of society. But to tell him that, where there is a question between the life or the pleasure of the social organism and his life or pleasure, the claim of the social organism must rank first, is to tell him what, we venture to think, you will not be able to prove with any arguments supplied by the "Data of Ethics," the reasoning of which, like the promptings of Nature apart from theism, point rather the other way. The chapter on the "Sociological View of Ethics" is not, at least I have not found it, the clearest in a book generally remarkable for perspicuity: but, if I do not mistake, it forecasts a diminution of the claims of society on the allegiance of the individual man, in proportion as militarism gives way to industry, and the need of protection against the violence of other social organisms becomes less.

In one remarkable passage Mr. Spencer seems practically to avow the inability of his principle to settle what have hitherto been deemed the plainest questions of morality:

In men's wider relations frequently occur circumstances under which a decision one or other way is imperative, and yet under which not even the most sensitive conscience, helped by the clearest judgment, can decide which of the alternatives is relatively right. Two examples will suffice. . . . Here is a merchant who loses by the failure of a man indebted to him. Unless he gets help he himself will fail; and if he fails he will bring disaster not only on his family but on all who have given him credit. Even if by borrowing he is enabled to meet immediate engagements, he is not safe; for the time is one of panic, and

others of his debtors by going to the wall may put him in further difficulties. Shall he ask a friend for a loan? On the one hand, is it not wrong forthwith to bring on himself, his family, and those who have business relations with him, the evils of his failure? On the other hand, is it not wrong to hypothecate the property of his friend, and lead him too, with his belongings and dependents, into similar risks? The loan would probably tide him over his difficulty; in which case would it not be unjust to his creditors did he refrain from asking it? Contrariwise, the loan would very possibly fail to stave off his bankruptcy; in which case is not his action in trying to obtain it practically fraudulent? Though in extreme cases it may be easy to say which course is the least wrong, how is it possible in all those medium cases where even by the keenest man of business the contingencies can not be calculated? . . . Take, again, the difficulties that not unfrequently arise from antagonism between family duties and social duties. Here is a tenant farmer whose political principles prompt him to vote in opposition to his landlord. If, being a Liberal, he votes for a Conservative, not only does he by his act say that he thinks what he does not think, but he may perhaps assist what he regards as bad legislation: his vote may by chance turn the election, and on a parliamentary division a single member may decide the fate of a measure. Even neglecting, as too improbable, such serious consequences, there is the manifest truth that, if all who hold like views with himself are similarly deterred from electoral expression of them, there must result a different balance of power and a different national policy: making it clear that only by adherence of all to their political principles can the policy he thinks right be maintained. But, now, on the other hand, how can he absolve himself from the responsibility for the evils which those depending on him may suffer if he fulfills what appears to be a peremptory public duty? Is not his duty to his children even more peremptory? Does not the family precede the state? and does not the welfare of the state depend on the welfare of the family? May he, then, take a course which, if the threats uttered are carried out, will eject him from his farm, and so cause inability, perhaps temporary, perhaps prolonged, to feed his children? The contingent evils are infinitely varied in their ratios. In one case the imperativeness of the public duty is great and the evil that may come on dependents small; in another case the political issue is of trivial moment and the possible injury which the family may suffer is great; and between these extremes there are all gradations. Further, the degrees of probability of each result, public and private, range from the nearly certain to the almost impossible. Admitting, then, that it is wrong to act in a way likely to injure the state, and admitting that it is wrong to act in a way likely to injure the family, we have to recognize the fact that in countless cases no one can decide by which of the alternative courses the least wrong is likely to be done.

In the first case nothing, according to common conceptions, could appear more certain than this, that a man has no right to borrow money under any circumstances, or for any purpose whatever, unless he is sure that he can pay, or, at least, has fully apprised the lender of the risk. In the second case, it seems equally clear that in the exercise of a public trust public duty ought to prevail over all private considerations, and that, though a man may be justified in abstaining from voting if the state fails to afford him protection against the tyranny of his landlord, he can not possibly be justified in voting

wrong. But we can easily see how, in both cases, the philosophy of the "Data of Ethics" breaks down. It finds itself involved in a hopelessly bewildering calculation of the relative amounts of pleasure and pain attending either line of conduct in its bearing on the sensation of the agent and of other people. Whether any other philosophy capable of distinct statement holds good is, of course, a different question, as we bear in mind throughout.

By the very method of his inquiry the author of the "Data of Ethics" is cut off from any appeal to human morality as essentially distinct from that of other animals. He is committed to the position that the conduct and ethics of man are merely an evolution of those of the mollusks. When he takes a woman suckling her child as his highest type of a right action, it is difficult to see why he might not as well have taken any other mammal. The sentence would run just as well, "Consider the relation of a healthy cow to a healthy calf. Between the two there exists a mutual dependence which is a source of pleasure to both. In yielding its natural food to the calf, the cow receives gratification, and to the calf there comes the satisfaction of appetite—a satisfaction which accompanies furtherance of life, growth, and increasing enjoyment." There is a *caveat*, as was said, to be entered against "higher" and "lower," applied to the earlier and later products of evolution; they carry with them the suggestion of a moral difference which might form a foundation for ethics. But, if the evolutionist were asked why the latter and more complex was higher than the earlier and simpler organism, we apprehend his only answer would be, that it was higher because it was later and more complex. If the pleasures of the other animals are less intense so are their pains, and from a large class of the pains which beset humanity they are altogether free. A sea-gull lives, it is said, longer than a man: it has found a sphere in which it has few enemies; it knows no care for the morrow, no moral effort, no moral conflict, no strivings after an unattainable ideal. At least it gives no sign of anything of the kind. Why is it to be dubbed lower?

Besides the list of pleasures denoting the conduciveness of the action to vitality, there may be said to be in the "Data of Ethics" a set of characteristics derived from perfection of evolution. Such are "adjustment of an action to an end," "definiteness," "exactness," "heterogeneity," "complexity," "multiformity," subordination of immediate to remote objects and of motives connected with presentative to those connected with representative and re-representative sensations, all regarded as placing the highest mammal at the top of the ascending scale; while the mollusks, with whose rudimentary ethics Mr. Spencer sets out, are at the lowest. Such, also, are the criteria stated in the terms of Mr. Spencer's special and, to common minds, mysterious theory of the movement of evolution, his "rhythms," and his perfect state of "moving equilibrium." Mr. Spencer, as he has

eloquently avowed; thinks the first Napoleon about the greatest enemy of his kind who ever lived. Yet in which of the attributes of perfect evolution did Napoleon fall short? Were not his actions as admirably adjusted as possible to their evil ends? Was he not in the highest degree "punctual," methodical, and exact? Was any man ever more multiform in his activities or heterogeneous in the parts which he enacted? Did any man ever keep his eye more steadily fixed on remote objects or play a longer game? No one can question the vastness of his brain-power, and his historian boasts that his head was the largest and the best-formed ever submitted to the investigation of science. History can not pretend to say anything about his "rhythm," but during a considerable part of his life, at all events, he may be said to have been in moving equilibrium, for he was always on horseback, and had so loose a seat in his saddle that he rode merely by balance, and when the horse stumbled was apt to be canted over its head, though the powers of evil always preserved his neck. He is a figure to be noted by agnostics, for, though he lived before positivism, he was a perfect positivist. He had, as he tells us himself, shut all religious ideas out of his mind as hindrances to action; he had learned to discard metaphysics and philosophy altogether as the dreams of ideologues; he insisted on positive education, and he took his own propensities as the parts of his nature which were to determine his conduct without respect for any moral conventions. There is a curious *jeu d'esprit* (such, no doubt, it is) which connects, across the gulf of centuries, Bonaparte with that other great positivist before positivism, Machiavelli. It is a copy of "The Prince," supposed to have been found in the Emperor's carriage at Waterloo, with a running commentary by his hand, showing the correspondence of his own policy with Machiavellism; and the likeness is very striking.

Are not "punctuality" and whatever it denotes as much shown in keeping a guilty assignation or a rendezvous of crime as in appearing at the hour fixed for a charity meeting? Was "the adjustment of an action to its end" ever more exact, were the qualities which adjust actions to their ends ever more signally displayed, than when Ravaillac, having marked his opportunity and chosen his position well, drove the knife, which he had chosen with care and thoroughly sharpened, at a single stroke into the heart of a king whose life was the hope of the world?

Mr. Spencer, in his present work, wisely forbears touching the question of moral necessity. So far as the "Data of Ethics" is concerned, therefore, he avoids the reef marked by the wreck of the automaton man. The reasonings by which automatism is supported, it may be noted by-the-way, are simply a reproduction of those of Jonathan Edwards, who was not in quest of truth, but of a philosophic basis for his Stygian dogma, and was himself half conscious that he had reduced his own argument to an absurdity when he found himself

logically compelled to ascribe to the All-Good the personal authorship of crimes; for, of course, it could signify nothing to the question of agency, if no new spring of action was interposed, how long the chain of mere instrumentalities might be. He was right in asserting moral causation, which is given us by consciousness, and without which the moral world would be a chaos. His fallacy lay in the assumption that moral causation was the same as physical. What has been inappropriately called free-will may be roughly defined as the difference given us by consciousness between moral and physical causation. Though it is the most certain, as well as the most momentous, fact of our being, we shall probably never succeed in precisely formulating it by any phrase that we can devise, even supposing it to be fixed, and not to be increasing, with our ascent from a lower to a higher, from a more material to a more spiritual life.

Though not a declared automatist, however, Mr. Spencer is, by virtue of his general philosophy, a necessarian. He holds that evolution, which is the order of the universe, "consists in a change from an indefinite coherent homogeneity to a definite coherent heterogeneity, through continuous differentiations and integrations." The universe may well have heaved a sigh of relief when, through the cerebration of an eminent thinker, it had been delivered of this account of itself. Yet it must be a curious universe if this is its secret. As the Yankee said of the enormously rich church with a very scanty congregation, "it must be doing the smallest business on the largest capital of any concern in this State." Man, the insect, aims at producing things which we feel to be noble, and which, according to the measure of his span, will endure; but the power of the universe does nothing but turn the homogeneous into the heterogeneous and back again through the same tread-mill round of differentiations and integrations, every round ending in the same fatal "equilibration" and total wreck of all the results of the process. The higher the fruits, the more senseless the destruction. What set the homogeneous moving in the first instance and made it become the heterogeneous? This would be the question which we should have to ask if the law were tendered as a physical explanation of the origin of the world. Why, we might also ask, is the coherent to be called the heterogeneous, and the incoherent the homogeneous? Might not the terms as well be reversed?* But it is enough here to say that the theory is mechanical necessarianism, and that as such it is scarcely reconcilable, in a scientific point of view, with the high strain of ordinary morality and the passionate denunci-

* We have always suspected that with regard to the sociological portion of Mr. Spencer's theory of evolution, and perhaps even with regard to the whole theory, a very considerable part had been played by our old friend the division of labor. Adam Smith knew the bounds of his discovery, if discovery it could be called. Though the employments of men diverge and multiply, the unifying influences of civilization generally on the members of a community are greater than the diversifying influences.

ations of wrong which we find in such passages of Mr. Spencer's work as this :

> Such a view (of the progress of altruism) will not be agreeable to those who lament the spreading disbelief in eternal damnation; nor to those who follow the apostle of brute force in thinking that because the rule of the strong hand was once good it is good for all time; nor to those whose reverence for one who told them to put up the sword is shown by using the sword to spread his doctrine among the heathens. The conception set forth would be received with contempt by that Fifeshire regiment of militia, of whom eight hundred, at the time of the Franco-German War, asked to be employed on foreign service, and left the Government to say on which side they should fight. From the ten thousand priests of the religion of love, who are silent when the nation is moved by the religion of hate, will come no sign of assent; nor from their bishops, who, far from urging the extreme precept of the master they pretend to follow, to turn the other cheek when one is smitten, vote for acting on the principle strike, lest ye be struck. Nor will any approval be felt by legislators, who, after praying to be forgiven their trespasses as they forgive the trespasses of others, forthwith decide to attack those who have not trespassed against them, and who, after a Queen's speech has "invoked the blessing of Almighty God" on their counsels, immediately provide means for committing political burglary.

This is enough to show that, whatever the writer's moral system may be, his own moral sentiment is strong. But, surely, it is a splendid inconsistency. The bishop and the Fifeshire militiamen were in certain stages of evolution, or, in other words, of progress from the homogeneous to the heterogeneous, through the necessary differentiations and integrations. The Episcopal organism in its state of comparative homogeneity could no more help being fond of converting Afghans, by killing them and burning their cottages, than a tiger can help wanting to eat the bishop, or the Buddhist sage in Mr. Arnold's "Light of Asia" can help wanting, in the immensity of his benevolence, to be eaten by the tiger. Bishop and militiamen alike will surely give their censor the crushing answer that they could not possibly be more differentiated or nearer the perfection of moving equilibrium than they are, without breaking the Spencerian law.

Another strong point, which any organism indisposed to altruism might make, is the warrant apparently given to purely selfish action by the struggle for existence. "In large measure," says Mr. Spencer, "the adjustment of acts to ends which we have been considering are components of that 'struggle for existence,' carried on both between members of the same species and between members of a different species; and, very generally, a successful adjustment made by one creature involves an unsuccessful adjustment made by another creature, either of the same kind or of a different kind. That the carnivores may live, herbivores must die; and, that its young may be reared, the young of weaker creatures must be orphaned." Why, a Borgia or a Bonaparte will ask, is the law to be confined to the case of carnivores and herbivores? Do not I equally fulfill it by making a prey of the

herbivores of humanity, or by destroying in any way I can other carnivores who happen to stand in my way? If my acts are well adjusted to these ends, as Machiavelli says they are, why are they not good? The result will be that survival of the fittest which science proclaims to be the decree of Nature. Is it not difficult to find an answer which will not involve what Dr. Van Buren Denslow derides as theistic altruism?

The motive power to which, at bottom, Mr. Spencer's ethic mainly appeals in urging to moral effort or self-restraint, is the hope of a future social state, which in his, as in other agnostic philosophies, fills the void left by the discarded hope of a future life. Here, again, he is confronted by the logical consequences of his mechanical necessity: what must come will; we need not make any effort or forego any gratification to bring it about; the "co-operation" which he speaks of is needless, or, rather, illusory; nor is it in our power to forestall the process of evolution. Apart from this, however, the prospect of a social goal indefinitely distant, and to be attained not by the individual man, but by humanity, influences only highly educated imaginations and refined natures, if it greatly influences even these. What does Bill Sykes, what does a director of the Glasgow Bank, what does William Tweed, what does Fiske, or St. Arnaud, or St. Arnaud's employer, care about the fortunes of humanity a million years after he as an individual being has ceased to exist? What impelling force, to keep that side of the matter in view also, will such visions have with the multitudes of common people, unread in the "Philosophie Positive," on whose conscientious performance of duty society depends, and whose goodness is the salt of the earth? The philosophers of the ultra-evolutionary school put out of sight, in the scientific sweep of their social theories, two commonplace facts—individuality and death. Death some of the philosophers of the last century thought might be abolished: those of the present appear to think that, if we will all be quiet and refrain from ill-omened words, it may be hushed up. They constantly quote Spinoza's saying, that true wisdom concerns itself not with death but with life. Spinoza had inherited the creed of religious secularism, which in his active intellect took the form of pantheism—without, however, losing its essential character as a belief generated at a stage before the wisdom or the folly, as the case may be, which concerns itself with death and the life beyond death, had come into the world. But does any one seriously believe that man can now be put back into that infantine state in which he once passed his days like the other animals, without spiritual aspiration, and, like them, lay down at last to sleep without hope or fear? What a clearance of art, architecture, poetry, philosophy, and history does a return to contented and dreamless secularism imply! Yet the other part of the undertaking is even more arduous. That men should be made to feel themselves members one of another, granting the theistic hypothe-

sis, is not absolutely impossible ; it may even be said that, tremendous as the obstacles were, in a space of time very short compared with the total duration of the race, an appreciable, if not a great, progress has been made. At least, it will hardly be denied that in philanthropy the world at the present day is more advanced than it was in the reign of Tiberius. Of that, Mr. Spencer's own sentiments are proof enough. In no ancient writer is there to be found a protest like his against the oppression of the weaker races. But to get this sensible, warm motion to lose itself in a mere generalization, whether the generalization be humanity, animality—which for all that we can see has just as good a claim as humanity—or simply evolution, and to be content with the prospective welfare of this generalization instead of thinking about its own, does seem to us absolutely impossible, unless it be in the case of a very extraordinary temperament, or during the brief continuance of an artificial mood. Besides, all ends sooner or later in a physical catastrophe—in the catastrophe, according to Mr. Spencer, of equilibration ; and how can it be expected that people will be animated to moral effort by the idea that they are "co-operating with evolution in producing the highest form of life," when evolution itself flings all the results of so much differentiation and integration back into homogeneity with the recklessness of a child overturning its castle of sand ?

There surely goes a good deal of quasi-religious faith to the making of this evolutionary millennium. We have in effect to assume that all the agencies of progress now at work will continue in full force, notwithstanding the departure of the beliefs with which some of them have been hitherto bound up, and that no new evils will emerge. Unhappily, the last part of the assumption is contradicted by the evidence alike of the sanitary, social, and political spheres. That physical Nature will become kinder to us there seems no reason to believe. The author of the "Data of Ethics" does not promise that she will : he says that flood, fire, and storm will always furnish occasions for the display of heroism—heroism which there will no longer be any very tangible motive for displaying. On the progress of science we may count ; and this is so important as to make us feel that humanity altogether has at last struck into the right path. Yet, if we shut our ears for a moment to the pæans which are being sung over telegraphs and telephones, we become conscious that, while science has been making miraculous strides, the masses have not yet made strides equally miraculous, either in character or in happiness.

Mr. Spencer seems to expect unbounded improvement from the final ascendency which he confidently anticipates of industry over war. He is no doubt aware that the distinction between the military and the industrial types of society is familiar, though his use of it as a universal key to history is new. There never can have been a purely military state of society ; somebody must have produced, or there would have been nothing for the warriors to pillage ; nor is the difference between

the ancient community, in which there was a warrior caste of masters with an industrial people of slaves, and the modern community, in which there is an industrial people of citizens with a standing army of professional soldiers, though most momentous, quite so radical as Mr. Spencer assumes. The most perfect type of a purely industrial community, perhaps, is China ; not a very encouraging example, as the Chinese, besides their servility, their unprogressiveness, and their total lack of political life, are untruthful, vicious in some other respects, mean, and, as their punishments show, abominably cruel. In London and our other great commercial cities the military element is trifling, even taking in the volunteers ; yet of vice and unhappiness there is surely enough. Biographers at some future time, seeking in Mr. Spencer's works materials for a life of the great philosopher, will find that he evidently had experience in his own person of some of the special evils of industrialism, such as plumbers who make business for builders, and crockery-breaking servant-girls, to whom he was compelled to apply that article of his ethical code which forbids you, when your crockery is concerned, to allow your line of conduct to be decided by altruism alone. These are but trifling instances of an industrial depravity over which jeremiads innumerable have been chanted, and which in its consequences even to life is hardly less destructive than war. The final transition will also be a most critical affair. A society wholly destitute of military force and without martyr spirit, which can hardly exist apart from religion, will be at the mercy of any surviving six-shooter of the past.

In a recent number of this review there was an article by Mr. Spencer on "The Industrial Type of Society," * to which was appended a note drawing a comparison between the morality of religious communities and that of savages who have no religion. The Christian era was represented as a hideous succession of public and private atrocities, innumerable and unmeasurable, of bloody aggressive wars, ceaseless family vendettas, bandit barons and fighting bishops, massacres—political and religious—torturings and burnings, assassinations, thefts, lying, and all-pervading crimes. Nor was this description confined to the past. We were called upon to read the police reports, the criminal assize proceedings, the accounts of fraudulent bankruptcies, political burglaries, and criminal aggressions at the present day. With this picture we were invited to contrast the honesty, the truthfulness, the amiability, the mild humanity of the Bodo, the Dhimáls, the Lepchas, the Santáls, the Veddahs, the Arafuras, and the Hodas who have no notion of God nor belief in the immortality of the soul. Decisive judgment was given in favor of the savages by the philosopher, whom we can not suppose to have been indulging in mere rhetoric. But it will be allowed that the Christian nations are in general respects, and notably in everything pertaining to science, the most civilized. If in the

* "Contemporary Review," October, 1881.

most important matter of all they have retrograded to this extent, what becomes of the hope of civilization ?

Yet Mr. Spencer himself sees the promised land of evolutionary adjustment and felicity from a very advanced Pisgah. His man is a man in a suburban villa with a good business in the city, who has only to be content with a sufficient income, avoiding the moral gulf of overwork, and that of "snatching a hasty sandwich," instead of taking a regular luncheon every day. Alas ! to say nothing of the myriads who in the past have lived and died in slavery and misery of all kinds, how many centuries must elapse before the question between a hasty sandwich and a regular luncheon becomes a practical one for any appreciable portion of mankind ! To do too much office-work is bad for health, and therefore, as Mr. Spencer most truly says, bad in every way ; but how many are there who must either do too much work or starve ! It is not healthful to be on the wintry Atlantic clinging to the frozen shrouds, to pant all day beside the fiery furnace, to be delving in the dark mine, to be sitting as a cab-driver exposed to all weathers, to be toiling as a farm-laborer with overtasked sinews from dawn to dusk. Of the labor which is the lot of most men, and in which their lives are almost entirely spent, very little is, like that of the artist, relieved by any sense of enjoyment ; the bulk of it is drudgery and nothing else. Schopenhauer exaggerates, of course. Were it not so, the end, in spite of his super-subtile objection to the exertion of will in self-destruction, would be universal suicide. There is happiness in life ; above all, the happiness of affection, though it is in this that we most keenly feel the sting of death. Yet if this life were all, and if enjoyment were the object of being, it would be difficult to deny that the pessimist had a formidable case, or that the world, on the whole and for the majority of mankind, was a failure. It is, at least it may be, otherwise if the theistic hypothesis is true, if the secret of the universe is not mechanical but moral, if the paramount object is the formation of character, and if the results of effort are to endure, in any form whatever, beyond the physical catastrophe of the planet. Trying to be good is within the power of a galley-slave ; and it is conceivable that by being ever so little better than himself the most abject of mankind may cast into the moral treasury a mite more precious in the estimation of the Author of our moral being than the effortless virtue of a born seraph. In touching upon such points we feel that the criticism which repels a physical account of morality is not merely destructive, but conserves something on which it is possible that a rational theology may hereafter be partly based.

In short, while we find, as was said before, in the "Data of Ethics" much that is acute, much that is eloquent, much that is interesting, we do not find in it a new basis of morality. We do not find a practical answer to the question which was put at the beginning. We do not find anything that, on the mass of mankind, is likely to act as

a strong inducement or as a strong deterrent. We do not find anything that can be relied on to save society from the danger of a moral interregnum. An exaggerated interpretation is not to be put upon that phrase. Society will hold together, and the milkman will go his round. For that, daily needs, habit, human nature, the examples of China and Japan, both of which are agnostic, sufficiently answer. Society has held together during former intervals between the fall of one morality and the rise of another ; but it has been in rather a sorry way. Things have righted, but before they have righted there have been times to which nobody wishes to return. The continuity of history is indisputable ; yet it is not such as to preclude very terrible convulsions ; and surely the doings of nihilism, which in its speculative aspect is clearly a product of the present disturbance of religious and, at the same time, of ethical beliefs, are warning enough of the existence of subterranean fires. Once more, it is not from the personal tendencies of the distinguished party which surrounds an intellectual tea-table that we can gather with certainty those of the masses inflamed by fierce passions and goaded by animal wants, or even those of genius itself, like that of Napoleon, in pursuit of selfish aims. That all will be well in the end, theists, at any rate, must implicitly believe ; yet the day of salvation may be distant.

"It is strange," says Mr. Spencer, "that a notion so abstract as that of perfection, or a certain ideal completeness of nature, should ever have been thought one from which a system of guidance could be evolved." Call the notion abstract, and the remark may be true. But it is certain that a personal type, or supposed type, of perfection, has furnished Christendom with guidance, with a rule of life at all events, up to this time. The sudden disappearance of that type must fill all, except the most serenely scientific minds, with misgivings as to the immediate future, it being admitted by "our great philosopher" that there is nothing to be put in its place.

There are one or two points which, though not strictly pertinent to the present inquiry, it may not be wholly beside the mark to notice. One of these relates to the theistic notion of morality, which we can not help thinking the author of the "Data" misapprehends, so far as rational theists are concerned. "Religious creeds," he says, "established and dissenting, all embody the belief that right and wrong are right and wrong simply in virtue of divine enactment." In another passage he represents the religious world as holding that "moral truths have no other origin than the will of God." There is a fallacy in the term "will." A law is not made by the will of the legislator ; it is enforced by his will, but it is made by his nature, moral and intellectual, the goodness or badness of which determines its quality and the salutariness of obedience. Wise advice given by a father to his children is useful in itself, not merely because he gives it. Moreover, what a rational theist may be said to hold is simply that our moral

nature points true to that of Him in whom we have our being ; that he is with us when we do right, against us when we do wrong ; that our well-doing moves his love, our evil-doing his aversion. There is nothing apparently more absurd in this than in believing the same thing with regard say to a friend, or even with regard to the community of which we form a part, and the good-will of which is a motive and a support of our rectitude. Nor is there any sort of necessity, so far as this belief is concerned, for entangling ourselves in a metaphysical labyrinth by going behind the divine nature and speculating on the possibility of its having been other than it is. Being is an inscrutable and overwhelming mystery : there is no more to be said.

That religion had its origin in primeval worship of the ghosts of ancestors or chiefs, and that, these ancestors or chiefs having been ferocious cannibals, we are hence enabled to account for the belief in propitiation by self-torture and the other diabolical characteristics of modern creeds, is a theory which Mr. Spencer habitually propounds as certain and almost self-evident. Scientific the theory may be, and on questions of science the utmost deference is due to its inventor's authority : that it is historical must be denied. In truth, when it appeared some of us could not help being reminded of Voltaire's prompt explanation of the fossil shells found on mountain-ranges, and adduced by ecclesiastical writers in proof of the Deluge, as cockles dropped by pilgrims from their hats. Euhemerus explained the Greek mythology in some such way, but his explanation has not been applauded. Not in the Hebrew Scriptures, not in the Rig-Veda, not in the Zendavesta, not in any of the monuments of primitive religion which philological science has been placing before us, not in any important mythology, whether Greek or of any other nation, can we find the slightest confirmation of the cannibal chieftain view. Everything seems to show that the earliest religious impressions were those made by the great powers of Nature, especially by the Sun in his glory ; and that this was the real origin of natural religion ; though, be it remembered, there must have been a religious impressibility, however rudimentary, in man, otherwise religious impressions could not have been made. As man advanced, the power seen through his moral nature became, instead of those seen with his eyes, the paramount object of his worship. There would surely be something utterly preposterous in the supposition that evangelical Christianity was a survival of the primitive worship of dead chieftains. Mr. Spencer seems to have swallowed whole Mr. Tylor's theory of animism, and to have given it an application which was not given it by its acute and learned author ; for Mr. Tylor, if I do not misunderstand him, would allow that Nature-worship was the origin of religion. The result, at all events, historians will say, is an unhistoric presentation of the most important subject in the history of opinion. In his volume on "Ceremonial Observances," Mr. Spencer maintains the surprising thesis that ceremony

was primordial, and that politics and religion (or, to use his exact expression, political and religious control) were developed out of it by divergent evolution. His proof is the similarity of the modes in which reverence is shown to gods and to political rulers, and which, he says, denotes the kinship of the two sets of observances and their community of origin. In tracing this similarity he allows his fancy a pretty free range, as, for example, when he identifies the visit of a worshiper to a temple with a morning call paid to a great man, and the payments made for the support of a Christian clergy with sacrifices to a heathen deity. But it does not occur to him that man, being provided with only one set of organs of expression, is obliged to use them in the case of a ruler as well as in that of a god, and may do so without at all confounding in his mind the different characters and claims of the two. The abject adulation which deified the Roman emperors is a proof of this, not a contradiction ; for the adulators were perfectly aware that they were giving to a man that which properly belonged to a god, and in the profanation lay the very point of the sycophancy. So with regard to the names of God, which Mr. Spencer thinks we shall be much startled by finding to have been originally descriptive words, and to have expressed superiority. Man has no celestial vocabulary. However distinct his conception of God might be from his conception of anything else, he would have to use the same words to express his reverence in this case as in that of a father or a chieftain. We do not see that the question as to the origin of religion is in any way affected by this discovery. Men speak now of the majesty of the king and the majesty of God ; of the honor due to one as well as of the honor due to the other, without any confusion of ideas as to the respective natures and claims of the two beings. The most startling thing surely would have been to find a name for the Deity, unconnected with anything else in human thought or speech, a linguistic aërolite, as it were, dropped from the sky.

Mr. Spencer's view of the origin of religion is perhaps not unaffected by his extreme notion as to the importance and influence of militarism, of which he sees everywhere the malign traces. According to him, the Home Office, when it crops the head of a convict (and washes him), is unwittingly perpetuating the custom of taking trophies by cutting off the hair. When you give a man a lower seat at table, or in an assembly, the survivalist sees in the act a desire to have the force of gravity on your side in the conflict for which everybody is mentally preparing. There is something rather laughable in the idea that the high table on a dais in a college hall is a military vantage-ground from which the "don" may be able to make an onslaught on the under-graduates with the force of gravity on his side. Between sun-myths and survivals there will soon be no room left for any natural belief or action.

The twist, as many readers will deem it, extends to every subject

connected with religion, among others to that of asceticism, at which Mr. Spencer tilts ever and anon with a good deal of vehemence, and of its connection with Christianity. Religion is represented as still imbued with the belief, derived from blood-thirsty ancestors, in a diabolical God who is to be propitiated by self-torture. Nothing of the kind is to be found in the Gospel, in the apostolic fathers, or in any form of evangelical Christianity. Jesus was denounced by his enemies for not being an ascetic. Paul lived a live of self-denial and voluntary exposure to suffering and peril ; but it was not for the purpose of self-torture, it was, like his celibacy, for the purpose of propagating the Gospel, as a soldier undergoes toils and privations for the sake of victory, or a man of science for the sake of a discovery. Even the Baptist was not a self-torturer—he was a reformer preaching by austerity. Launched into the world, Christianity felt the influence of the various currents of thought and tendency—Hellenic, Roman, Alexandrian, and Oriental—nor did it escape that of the fakirism which had been generated in the mud of the Ganges. The monks of the Thebaid were fakirs, and may be left to Mr. Spencer's mercy. But so was not Benedict, or Bernard, or Anselm. Western asceticism on the whole corresponded to its name, which denotes not self-torture but self-training—the self-training of the spiritual athlete. Its central idea was that of liberating the soul from the shackles of the flesh in order to its complete union with the Deity. Chimerical it was, no doubt, and extravagant in some of its manifestations, but it was not diabolical, nor did it point to anything diabolical in the nature of the ascetic's God ; and it is by no means clear that, in such a case as that of Anselm, it would not have stood Mr. Spencer's test of pleasure, though the pleasure would have been of a peculiar and perhaps fantastic kind. It was compatible with immense usefulness, social, educational, and even industrial, for monasticism in its prime was a great agricultural improver. Moreover, as alchemy helped to give birth to chemistry, asceticism may have helped, by conquering the brutish appetites which hold unlimited sway over the barbarian, to give birth to rational temperance. No portions of the "Data of Ethics" are better worth reading than those in which the writer inculcates attention to health, both for our own sakes, and for the sake of the offspring to whom our constitutions are to be transmitted ; and preachers, if they wish to be practical, might do a great deal of good by dwelling oftener on the last point. But, waiving the theological form of expression, it is difficult to put the duty of caring properly for the body higher than it was put by the apostle who called the body the temple of the Holy Spirit. And though no one wishes to detract from the dignity of physiological science, or to underrate the benefits which a diffused knowledge of it might confer, it is certain that the temperance, soberness, and chastity which Christianity has labored not without effect to inculcate, are keeping unscientific people in perfect health with the cheerfulness

which attends it, while even a thorough knowledge of physiology seems often to be of little avail for self-management.

In conclusion, I must say again that I am not here contending that theism or that Christianity is true, nor do I blink the tremendous difficulties with which at this moment the proof of both of them is beset. I stand up for history, and decline either to reject existing beliefs before they are confuted, or to accept new beliefs before they are proved. There is nothing in this inconsistent with the most grateful veneration for science, or the most perfect willingness to embrace any kind of truth. *Vincat veritas, ruat cœlum.* Only, if the catastrophe does happen, it will surely be better, with such spirit as we can summon, to confront the void, and not to try to delude our souls by putting figments in the room of that which has been lost.— *Contemporary Review.*

FOSSIL SEEDS.*

By STANISLAS MEUNIER.

THE attention of Adolphe Brongniart was for a long time given to the silicified fossil seeds which are inclosed in the beds of Autun and Saint-Étienne. The illustrious naturalist found the study a virgin domain, and an appropriate complement to his great labors on fossil plants. Although our knowledge in this department is still very far from complete, Brongniart was able to lay the foundation of a classification of these interesting remains; and it gives us pleasure, as much in the historical point of view as in its bearing on botany, to give a succinct idea of it here.

The seeds which Brongniart examined are divided into two principal groups:

A. Seeds with a binary symmetry, more or less flattened and bicarinated. This natural group includes the genera *Cardiocarpus* (Fig. 1, 1), *Rhabdocarpus* (Fig. 1, 2), *Diplotesta*, *Sarcotaxus*, *Taxospermum*, and *Leptocaryon*, analogous to genera of the existing family of the *Taxineæ*.

B. Seeds with a symmetrical radiation around an axis, in which the number of the divisions varies from three, as in *Pachytesta*, *Trigonocarpus* (Fig. 1, 3), *Tripterospermum*, to six, as in *Ptychotesta*, *Hexapterospermum*, *Polypterospermum* (Fig. 1, 5), *Polylophospermum* or eight, as in *Eriotesta*, *Codonospermum* (Fig. 1, 6), or the section of which is circular, as in *Stephanospermum* and *Ætheotesta*. These seeds appear to represent the *Sigillariæ* and the calamites, and some genera of the cycads and conifers.

* Translated for "The Popular Science Monthly" from "La Nature."

Before entering upon the account of his studies, Brongniart describes, in an introductory chapter, the periods of vegetation and the different floras that have succeeded each other on the earth's surface. "We may consider," he says, "as having been deposited during a same epoch of the creation of the vegetable kingdom, and as belonging to

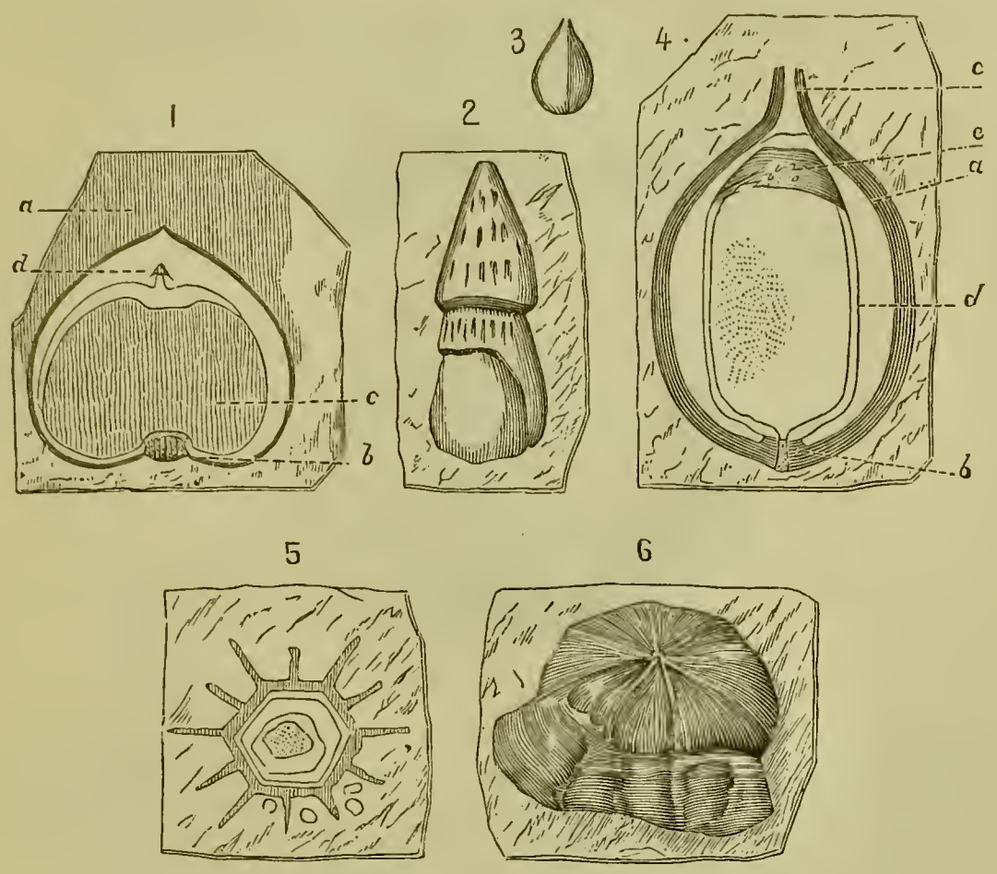


FIG. 1.—SPECIMENS OF FOSSIL SEEDS EXAMINED BY ADOLPHE BRONGNIART.—1, *Cardiocarpus drupaceus*. Section through the plane of the keel. *a*, thick testa; *b*, chalaza; *c*, kernel and albumen; *d*, micropylar extremity of the kernel (natural size). 2, *Rhabdocarpus conicus*. Grand' Eury. General form from a specimen that was broken before preparation (natural size). 3, *Trigonocarpus pusilus* (natural size). 4, longitudinal section passing through the chalaza and the micropyle (magnified five times); *a*, testa; *b*, chalaza; *c*, micropyle; *d*, kernel; *e*, cavity on the summit of the kernel, with grains of pollen. 5, *Polypterospermum Renaultii*, transverse section (natural size). 6, *Codonospermum anomolum*, external view, as it appears in the broken rock.

a same ancient flora, the different beds in which we find the same collection of species, and during the deposition of which some at least of these species have persisted from the beginning to the end of the local phenomena.

"This is what constitutes an epoch in the geological study of vegetable fossils; but several of these epochs often succeed one another, all preserving a considerable number of common characters in the nature and relative proportion of the principal families that belong to them; and this succession of analogous epochs forms a period in the history of the successive development of the vegetable kingdom."

The successive creation of different vegetable forms is thus divided into three long periods, called the reign of the Acrogens, the reign of the Gymnosperms, and the reign of the Angiosperms—"expressions indicating only the successive predominance of one or another of these three grand divisions of the vegetable kingdom, without neces-

sarily supposing the complete exclusion of the two others." The reign of Acrogens was manifest during the Carboniferous and Permian periods; the reign of the Gymnosperms during the Vosgian and Jurassic; and the reign of the Angiosperms during the Cretaceous and Tertiary periods.

Proceeding to the study of the fossil seeds found silicified in the coal-beds of Saint-Étienne, M. Brongniart makes a comparative review

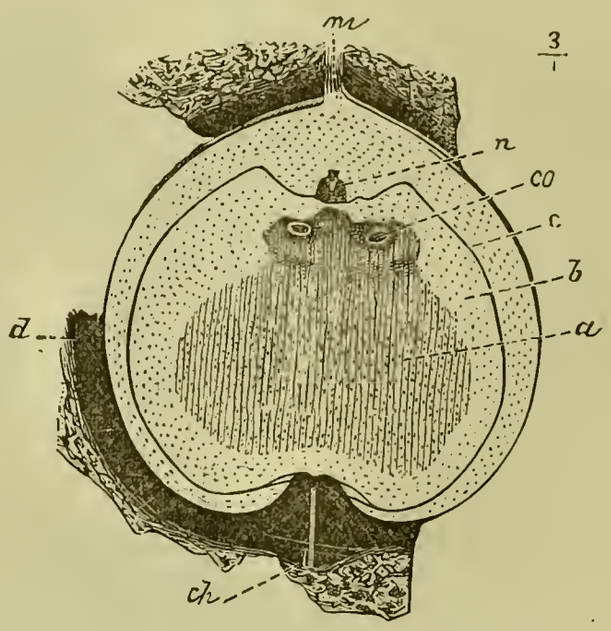


FIG. 2.—CARDIOCARPUS SCLEROTESTA, LONGITUDINAL SECTION PASSING THROUGH THE MICROPYLE, THE CHALAZA, AND THE PRINCIPAL PLANE OF THE SEED (magnified three times). *a*, albumen, well preserved, inclosed in the embryonary sac; *b*, hardly visible remains of the embryonary sac; *c*, envelope of the kernel reduced to its epidermis; *co*, the two corpuscles, placed symmetrically in the plane of the seed, below the pollinical chamber; *m*, the pollinical chamber, but slightly developed in this group of seeds; *d*, endotesta; *mi*, micropylary canal of the testa, leading to the pollinical chamber; *ch*, chalazian region of the seed.

of the structure of the seed and ovule of the cycads, and of different silicified seeds of the coal-beds, and announces one of the most remarkable discoveries in fossil botany, the value of which consists in the light which the study of fossils is made to cast upon the interior anatomy of existing forms. A singular feature was observed in the organization of a considerable number of these seeds, in that there existed, near the summit of the kernel, and in the corresponding part of the micropyle of the testa (or outer integument), a cavity in the cellular tissue, containing nearly always granules or free vesicles, which could only be regarded as grains of pollen; and from the presence of which M. Brongniart was led to designate the cavity as the pollinical chamber. Nothing of the kind is known in existing gymnosperms. The cycads, however, had been previously indicated as presenting analogies with the Palæozoic plants under study; and M. Brongniart's views upon this point have received a striking confirmation from the observations of the gardener of the museum and of M. Renault. The published volume of the "Lectures on Fossil Botany" of the latter gentleman contains a carefully copied plate, showing a similar pollinical chamber in the *Ceratozamia Mexicana*. Figs. 2 and 3 show the grains very plainly in *Cardio carpus sclerotesta*.

The work, of which we have given a brief summary, "Recherches sur les Graines Fossiles Silicifiées," consists of twenty-one plates, giving accurate and exactly colored representations of the seeds examined, with careful explanations. The completion of the text was interrupted

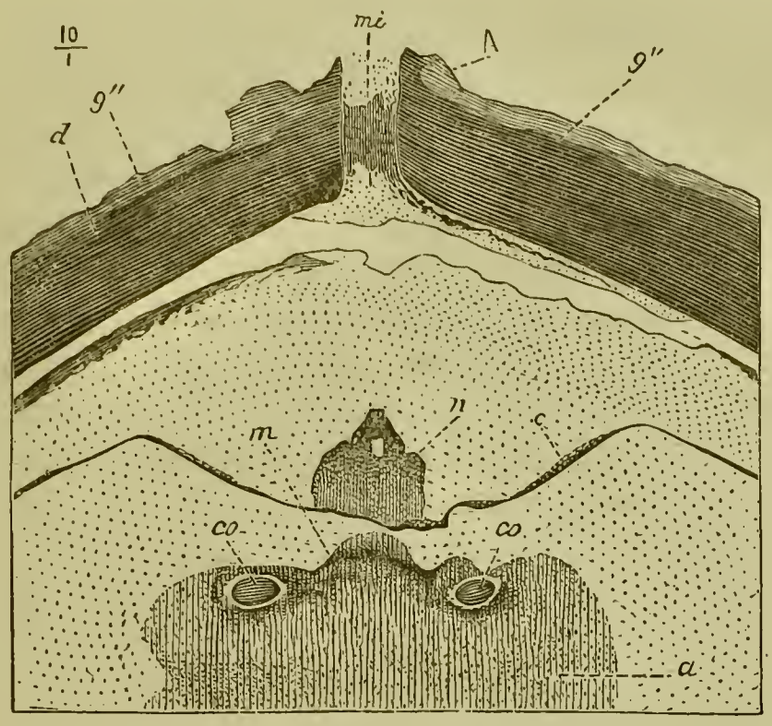


Fig. 3.—Part of the Preceding Figure, magnified Ten Times.

by the death of the author, but the plates are finished, the details in them that were left lacking having been supplied by M. Renault, after comparison with the identical specimens. The whole work, in its present form, constitutes a real monument erected by pious hands to the memory of the illustrious founder of the science of fossil botany.

THE UNAWEEP CAÑON.

By HENRY GANNETT.

OF all the physical features of the earth, the courses of rivers are among the most unchangeable. Once outlined, they are adhered to with a wonderful tenacity. Only a general change in the slope of their basins will usually suffice to divert them from their original courses. Mountains and plateaus may rise across their paths, but, like a saw, the river cuts its way through the obstacle. It is very rare to find a case where a river has been diverted from its course by the rising of a mountain-range or other minor elevation across it, while numberless instances of rivers having overcome such obstacles are to be seen in all mountainous regions. The Cordilleran region of the West presents us with many such examples. Many are familiar with the gorge by which Green River passes the Uintah range, in Wyoming

and Utah, where the river has apparently preserved even its minor sinuosities in a cañon thousands of feet in depth. The Colorado River system is a magnificent example of the persistence of rivers. Established ages ago, when only the great general contour of the region was outlined, it antedated all the ranges of mountains and the plateaus which now diversify the surface. Nearly all these uplifts are at right angles, or nearly so, to the courses of the main streams ; yet, in all cases save one, the rivers have preserved their courses, by cutting gorges as the mountains rose. Grand River, which is one of the two largest branches of the Colorado, presents us with a fine succession of these cases. Indeed, it may be said that from its head, in Middle Park, to its mouth, the river is almost continually in trouble ; its course is nothing but a succession of gorges and of transverse valleys. In Middle Park it cuts several minor ranges ; at its point of exit from the park it encounters the Park ranges, which it cleaves from summit to base, making a cañon two to three thousand feet in depth. Then follow many miles of precipitous cañon, of great depth, which the river has carved in a high plateau. Emerging from this it meets a barrier, in what is known as the Hogback range, through which it levels a passage. Then follows for many miles a deep and narrow valley, between the Book Cliffs on the north and the Battlement Mesa on the south, which looks down on the river from a height of fully four thousand feet. Next, the Little Book Cliffs dispute its passage. These face the west, and toward the east, in which direction the river approaches, have a long and gentle slope downward. The river, holding steadily its course, enters the plateau, and rapidly eats its way below the surface. For many miles its cañon is so deep, narrow, and tortuous, that it can with the utmost difficulty be traced. At the face of the cliffs it emerges suddenly to daylight, in the broad, desert valley of the Gunnison. It holds its normal course across this valley, meeting the Gunnison on the west side. Then, right against the bluffs which border the Uncompahgre Plateau, it turns sharply at right angles, and flows off northwest, then west, then southwest again, and south, hugging closely the northern end of this great plateau, while on the right stretches away the desert expanse of the Grand River Valley to the base of the Book Cliffs.

It may be interesting to trace the behavior of a stream under these trying circumstances, when a mountain-range rises to dispute its path. We are not here concerned with those mountains which have arisen suddenly, by catastrophic action, but only with such as have been slowly evolved. In the former case, rivers, like all other natural features, share in the general overturning and destruction. When an elevation commences gradually across the course of a river, its first effect is to lessen the rapidity of the current above the crest of the elevation and to increase it below that point. The erosive power of a stream is proportional, other things being equal, to the

rapidity of its current. Erosion is therefore more rapid below the crest. But this erosion not only deepens the bed of the stream below the crest, but also pares away the crest, from down-stream upward, so that the point where the velocity of the stream changes is constantly tending up-stream. This point, then, will always be found above, i.e., up-stream from the crest of the obstacle. The degree of obstruction which this rising mass will afford to the stream depends, not at all on the absolute height to which it may rise, but to the degree of rapidity of its rise as compared with the erosive power of the stream. If the rate of rise be greater than the erosive power at first, it forms a temporary dam, and a lake is produced above the obstacle, which increases in depth until a sufficient fall is given to the stream to enable it to cut at the same rate at which the range rises. Then equilibrium is established, and the cutting goes on at the same rate as the range increases in elevation. When the rise ceases, the lake is gradually drained in whole or in part, as the river gradually cuts away the dam by moving its crest up-stream. A diversion of the stream can only occur by reason of a new channel being made accessible by the rise of water back of the dam.

Such, in brief, is the conduct of a river when its course is in danger from the rise of a mountain-range across it. It may be added that the many examples before us show that in nearly every case the river has had little trouble in sawing its way through them. Dams have seldom risen to very great height, nor have lakes collected to great depths.

One very remarkable case has, however, come under the writer's personal observation, of a river having been diverted from its course, and forced to take a long *détour*, having made an unsuccessful attempt to cut through the obstacle. In the western part of Colorado, near the Utah boundary, is a great plateau, known as the Uncompahgre Plateau. This is an inclined plateau ; its crest-line, starting at the northern base of the San Juan Mountains, runs off northwestward for fifty miles or more. It slopes with the dip of the strata at a low angle to the northeast, breaking off toward the southwest by a series of gigantic steps. Its crest ranges in height from 9,000 to 10,000 feet above sea-level, while the valley of the Gunnison, at its eastern base, has an elevation from 4,500 to 5,000 feet. At its eastern base lies the valley of the Uncompahgre, Gunnison, and Grand, which trends off to the northwest, and is occupied successively by the rivers above named. It is a broad, open valley, ranging in width from ten to twenty miles. In its southeastern and upper part it is traversed, near the middle, by the Uncompahgre River. Below the point where this stream joins the Gunnison, the latter hugs the base of the plateau, and is hidden by cañon-walls a few hundred feet in depth. The Grand, below its junction with the Gunnison, also flows close to the southwest side of the valley, and is, for a part of its course, in a low cañon, fifty to one hun-

dred feet in height. The last two rivers, entering the valley from the east, cross it immediately and at once take a general northwest course. The Grand flows on toward the northwest until it rounds the end of the Uncompahgre Plateau, when it sweeps slowly around to the southwest, and resumes its normal direction, still hugging closely the left side of the valley.

Southwest of the Uncompahgre Plateau the eye looks out over a stretch of low, arid plateaus, traversed, in deep cañons, by the Rio Dolores and its tributaries. This stream is an important branch of the Grand, entering it at the foot of the great valley, after that river has passed around the end of the Uncompahgre Plateau, and just as it plunges into the course of cañons by which it passes the Sierra la Sal.

Traveling along the crest-line of the Uncompahgre Plateau, one is interested in observing how sharply the crest-line serves as a water-parting. The drainage toward the west heads in the crest, without cutting it at all. The bluff-wall is everywhere continuous. But in the midst of these observations one is astonished by riding suddenly to the verge of a tremendous gorge, thousands of feet in depth, which apparently comes in from the west, and extends up into the plateau to the northeastward, against the slope and dip of the strata, as far as the eye can reach. Down in the depths he sees a small stream flowing westward. Descending into this cañon, an operation not easily performed at any point, and traversing its bed northeastward, he comes in a few miles to a divide in the cañon, and beyond the divide he finds a small stream flowing northeast into the Gunnison. This is the Unaweep Cañon.

The Unaweep Cañon is cut across the Uncompahgre Plateau, from the great valley of the Gunnison and Grand on the northeast, to the low, desert plateaus on the southwest. Its course is nearly southwest, and almost precisely at right-angles to the crest of the plateau. It joins the Gunnison at a point about six miles above the mouth of the latter stream, at an elevation above the sea of 4,600 feet. Tracing its course southwestward, its bed is seen to rise slowly, but not so rapidly as the level of the plateau, so that the cañon increases gradually in depth. The bottom rises to a divide, 7,000 feet above sea-level, and several miles east of the crest of the plateau. The walls at the divide have a height of 1,200 feet. West of the divide, the slope of the bed of the cañon changes slowly, and its descent to the westward does not become very rapid until the crest of the plateau is passed. At the crest, the height of the cañon-walls is 3,000 feet. At the point of junction with the Rio Dolores, the elevation is 4,618 feet above the sea, or practically the same as at its junction with the Gunnison.

The first few miles from the Gunnison the cañon is very narrow, has no great depth, and is cut in soft, recent, sedimentary rocks. This portion might easily have been cut by the small stream now occupying it—a theory which is supported by the fact that the strata here on

the margin of the plateau have been very much disturbed, which would easily have obliterated all traces of the original cañon. Entering the body of the plateau, the cañon suddenly assumes a greater breadth. As it increases in depth, it exposes a series of several hundred feet of stratified rocks, below which the granite comes to the surface. At the crest of the plateau the lower two thirds of the walls are of granite, the upper 1,000 feet being sedimentaries. From its northeastern end the cañon gradually widens from a bed-breadth of a hundred yards to one of at least a mile; at the crest, the cañon suddenly narrows to a mere stream-way, with rugged, vertical walls.

It is purely a cañon of erosion. There is no sign whatever of any local disturbance which could account for its existence. The strata on the two sides are perfectly conformable.

To attribute this cañon to the streams now occupying it is manifestly absurd. Not only are they utterly insignificant in comparison with the amount of erosion which has taken place, but no similar streams, of any magnitude whatever, could have cut the cañon down at the divide; neither could the western one have cut back into the plateau to any such extent. There is no lateral slope toward this cañon to determine the drainage of any considerable area of the plateau in this direction. It is plainly the scene of the defeat of a large stream, in its struggle to maintain its ancient course—of a victory of volcanic over aqueous forces. Another thing is equally apparent—that the stream here diverted came from the eastward and not from the westward, and that it was the Grand River. This is shown by the following considerations: (1) The general slope of the country, disregarding local accidents of topography, is from the northeast toward the southwest; (2) the direction of the course of Grand River above this cañon, which is almost precisely in line with (3) the character of its course, which shows that it antedated all other uplifts, and, as the Uncompahgre Plateau, from its trend and association, must have been coexistent with the rest, it must have antedated this also; (4) the features of the cañon itself afford the strongest possible evidence of a stream flowing southwest through it. The profile, with the summit *east* of the crest of the plateau, the slow descent west of the summit to the crest of the plateau, and the rapid descent beyond the crest, point unmistakably to this conclusion. The plan of the cañon is no less clear in its indications. It is well known that a rapid stream erodes its bed *downward;* a sluggish one, on the other hand, erodes laterally, thus broadening its bed. Here we have precisely these phenomena. Beyond the crest of the plateau, where the slope is great, the cañon is very narrow; while east of the crest, where the velocity of the stream must have been very much lessened, it widens rapidly, and then gradually diminishes in width.

At what stage in the rise of the Uncompahgre Plateau the river abandoned the unequal contest and took its present course around the

end of the plateau, we have no means of knowing definitely. Present relative elevations can not be relied upon as safe evidence. It is probable, however, that it was not far from the close of the rise, as otherwise the bed of the cañon, under the crest of the plateau, rising more rapidly than at any other point, would be the highest point, and the divide would be there instead of being several miles farther east.

Altogether, this phenomenon affords a very interesting study for the structural geologist and the geographer.

RECENT WONDERS OF ELECTRICITY.*

By W. H. PREECE, F.R.S.

II.

LAST week, when we had the pleasure of meeting, I endeavored to disabuse your minds of any such idea as that electricity was a fluid, or, in fact, any kind of matter. I pointed out to you that every electric phenomenon really was a form of that curious, mysterious agency that exists throughout nature, that produces all the work done on the face of the earth, that probably is at the root of life itself, called energy. Nevertheless, we can speak of electricity as though it were a distinct entity; precisely in the same way that we speak of sound, of light, and of heat. We know that sound and heat are not sensible to the touch, or taste, or sight; so electricity is of the same character, and is invisible and insensible in every shape or form. Moreover, we can not either create or produce energy; there is only a certain fixed quantity of energy in the universe, and all that we can do is simply to transform it into its different shapes, such as I illustrated to you last week. All physical phenomena, without a single exception, may be traced to the mere transformation of this energy. I showed you on the last occasion how, by simply winding a wire round a mass of iron, and sending a current of electricity through the wire, we could produce that form of energy called electro-magnetism. To-night I have to speak of one or two other forms in which this energy does its work—forms in which, when electricity is transferred through matter, it does work in some shape or another. The operation of the electric current, when passed through chemical compounds in solution or liquid, is to tear asunder the constituents of the compound, and to arrange them on different sides. A simple means of illustrating this is a glass jar, like the one before you, containing water and two glass tubes, each fitted with a stop-cock. When an electric current is passed through

* Lecture delivered before the Society of Arts, January 4, 1882, and reprinted from the journal of the society.

the water, the elements of water—oxygen and hydrogen—are driven asunder, and take refuge, as it were, in the right- or left-hand tube respectively. To prove that these gases have been collected, if a lighted match be placed over the hydrogen-tap, the hydrogen will give evidence of its presence by inflammability ; but, if the match be blown out and immediately presented to the tap of the tube containing the oxygen, that gas will make its presence evident by relighting the match. The effect of the passage of electricity through water is something like the effect which would be produced by a storm, or other agency, in this room, which caused all the boys of this audience to go to one side, and all the girls to go to the other—excepting that in water there are always two parts of hydrogen to one part or volume of oxygen. Not only does the current tear asunder the oxygen and hydrogen of water, but it also breaks up the constituents of most of the chemical compounds, and the weight of material decomposed per second is an exact measure of the work done and of the current flowing. For instance, if we take a solution of sulphate of copper and pass electricity through it, the solution is broken up into copper and sulphuric acid, and, if a bunch of keys were put into the solution while the electricity was passing through it, the keys would receive a deposit of copper. If nitrate-of-silver solution were used instead of the sulphate-of-copper solution, silver would be deposited upon the keys or piece of metal inserted. Through the kindness of Mr. Bolas I am able to show you an experiment of this kind, which will enable me to give you a record of this evening's entertainment. I have here a large glass dish containing a liquid, which no doubt appears to you like water, but which is really a solution of the double salt of cyanide of silver and potassium. In this solution I now place a piece of sheet-copper, which you see has the usual appearance of copper all over it. Now, while that plate of copper is inserted to one half its extent in water, we will pass electric currents through the liquid from the hand dynamo-machine on the table [experiment proceeding], which cause the cyanide of silver to break up into cyanogen on one side and silver on the other ; and, if I take out the plate of copper, you see there has been deposited upon its immersed surface a coating of silver. Silver spoons and all the various kinds of electro-plate wares receive their silver deposit in the manner I have just shown you. Now, we will set this small dynamo-machine in action by turning its handle, thus converting the energy of the human body into electric energy ; and we will immerse a quantity of brass buttons in the liquid, which, when they have received their coating of silver, will be laid aside, ready for distribution as a memento at the close of the lecture. Through the kindness of Messrs. Elkington I am able to show you the handsome specimens of electro-plating which hang on the walls of the room, and which were plated at their works at Birmingham, by a process exactly similar in character to that I have described, except-

ing that steam-power is substituted for the manual labor you just saw for producing the electric currents.

We next come to the work performed by electricity in passing through solids. The result of that work is simply the production of heat. Before me you will notice two brass stands, and between them I will suspend a piece of fine platinum wire. I now join up one of my battery wires to one of the brass stands, and touch the other brass stand with the other battery wire; the effect appears as a red glow in the platinum wire. If I bring one of my battery wires from the bottom of the brass stand to the end of the platinum wire, the color of the glow becomes brighter; and, as I move my battery wire along the platinum wire, the glow or light produced by the high temperature in the platinum becomes more and more intense, until finally, when it reaches a certain temperature (about 3,000° Fahr.), the wire is ruptured, and falls to the ground. That is evidence that the passage of electricity, through solid conductors, produces heat, and the amount of heat produced is proportioned to the work done in the battery. Energy expended in one part of a circuit must be given out at another. If zinc is consumed in a battery, it generates a certain amount of energy; that energy must be evident in some other part of the circuit, and the heat you saw in the platinum was really the heat that would have appeared in the battery itself if we had not caused the current to flow through a solid conductor which offered a considerable amount of resistance to its progress, as compared with the resistance in the battery itself. This power of producing heat has been utilized in various ways, such as for firing fuses. [An Abel fuse was exploded.] At many places throughout the country, time-guns are fired by such an electric fuse to announce the Greenwich time current at a certain hour. Mines and torpedoes are exploded in a similar manner; quarries are blasted, and many other results are brought about by passing electricity through platinum wire placed in explosive substances, or by special fuses. I do not intend to frighten or alarm you, but for your amusement, and through the kindness of Professor Abel, I have had fuses fixed out of harm's way at various points round the room, and, when a small current is passed through them, you will hear the explosion produced. Those fuses might have been fixed miles away, and the same effect would have been produced, and from it you will understand how a number of charges can be fired, or a number of guns can be discharged simultaneously on board our large men-of-war.

The next branch of the subject is the work done by electricity in its passage through air and gases. I have shown you that, in its passage through liquids, it tears the constituents of the solution asunder; in its passage through solids heat is produced; and in its passage through air, it not only produces heat, but violent projection of material particles as well, which it renders incandescent, producing sparks, heat, and other disruptive effects. To illustrate this, I have provided

an Apps's induction coil, to which can be joined up vacuum tubes of various kinds, and through which the currents produced by the hand dynamo-machine will be passed. [A beautiful collection of vacuum tubes, fitted with various rarefied gases, was then shown, while the lights were turned down.] In those effects we have the result of electricity passing through air, and gases of extreme tenuity, and also an indication of the way in which electricity produces heat—and, therefore, light—in gaseous matter. All instances of artificial lighting or heating are simply due to the fact that we are able to produce heat, and heat of a very high temperature. It is a curious fact that all matter, whether metal or porcelain, carbon or lime, begins to emit light at precisely the same temperature, which closely approaches 1,000° Fahr., or, to be accurate, I believe it is 980° Fahr., so that, whenever it is possible by any means to raise any material to that temperature, light is emitted, and the intensity of light increases, until, in the case of carbon, when about 4,000° Fahr. is reached, the material is destroyed. In platinum, a lower figure (3,082°) represents the point of fusion. To obtain this very high temperature by electric currents, we must utilize higher means of producing the electricity than I have hitherto shown you. In the battery I have just used, the electric current was produced by the combustion of zinc ; but now I want to explain to you how, as I said, muscular power was converted into electric energy. The reason is simply due to the fact discovered by Faraday, that whenever a wire or conductor moved through the sphere or field of a magnet, it became electrified. I take up the brass rod before me and move it rapidly, and by doing so have, to a certain extent, electrified it by causing it to pass through the magnetic field of the earth. The earth is an enormous magnet—a fact which we know, because our compasses guide the mariners across the deep. The air in this room is under the influence of the earth's magnetism ; and if I move a wire or rod within that influence, at right angles to the lines of magnetic force, I cause it to be electrified, but only to an excessively small extent. The strength of the current produced depends upon the strength of the magnetic field, and upon the velocity with which the conductor moves across the field. Instead of having only one rod, or one wire, we have in this hand-machine an arrangement of a thousand turns of wire ; instead of having the weak magnetism of the earth, we have the powerful field of permanent magnet ; and, instead of causing it to move through the air by the velocity of my arm, we apply multiplying gear, which, as you see, imparts velocity to it of great rapidity. Thus motion, through a magnetic field, produces an electro-motive force. There never can be a continuous electro-motive force without some source of energy. Here we have mechanical energy expended, and all the conditions for the production and maintenance of a current. Energy expended in one point must be found in some form in another point. If it is not utilized, it is wasted.

Some of it must always be wasted, and the true economist will try and waste the least possible quantity. If I place a piece of platinum wire between the two wires connected with the hand dynamo-machine, you see that the muscular energy of my assistant, by turning the handle, generates currents of electricity, which give a red heat to the platinum wire. The energy of the body is thrown into the machine, the machine converts it into electricity, the electricity passes through the wire, which, by having work done upon it, is rendered incandescent, and, in consequence, becomes luminous. I have here a lamp containing a piece of platinum wire, and, if I connect it to the wires of the dynamo-machine [this was done], the platinum glows and gives us light. It is a machine precisely similar in principle to the one now before you, fixed under the arches on the Thames embankment, and worked by a steam-engine (lent for the purpose by Messrs. Robey) that is supplying currents of electricity to the lamps now lighting this room. There is an occasional throb in the light; this is produced by the unsteadiness of the engine, which was not specially prepared for the purpose, but was the best available. It is, in fact, an agricultural machine. There are two kinds of electric machines of this class. One is called the magneto-machine, like the one before you, because the magnetic field is produced by the presence of a powerful permanent magnet, which, I think, is visible to most of you, and which consists of several pieces of steel that have been magnetized. The other kind of machine is called the dynamo-machine, in which the magnetic field is produced by an electro-magnet, which is itself excited by the currents it generates, so that there is a kind of accumulative action; one current piles up the agony on the other current, and all of them together, acting on the electro-magnet, increase the total effects, until the iron is saturated with magnetism. So much as regards the production of currents for electric-lighting purposes. The motion of the conductor through the magnetic field may be caused by the energy of coal, which is consumed to generate heat and steam for working a steam-engine; or, as at Godalming, by the energy of water on a water-wheel; and it is very probable that, where water is available, it will be the most economical source of energy for electric-lighting purposes. Sir William Armstrong, at his seat at Craigside, near Newcastle-on-Tyne, has illuminated his house for some time by currents of electricity, produced by a water-fall in his grounds, so that, he says, his library and his drawing-room are lit by the river flowing through his grounds. As regards the light itself, there are two kinds of lamps. I have already explained and illustrated to you the fact that electricity in its passage through air produces sparks. I have here what is called an arc-lamp; in it two rods of carbon are held by two brass clips (not in metallic connection with each other), and the ends of the carbon are, when in action, a short distance apart. On joining up the wires to the brass clips the current flows, a bright light is instantly set

up in the air between the carbon points, and the arc is formed. This light is due to the passage of an infinitely rapid succession of particles of carbon which are projected across the air-space, which, in their high state of incandescence, produce light, and which in brilliancy would not compare unfavorably with that of the sun. The light from a larger arc-lamp would be far more brilliant than this, but I do not want to damage your eyes or my own. I have experimented on the electric light so much, that I have suffered great tortures from the irritating and exciting influence of its bright rays upon the retina of the eyes, and I advise all people who have an opportunity of examining the arc-light, not to look at it too much, or the eye-sight may be unfavorably affected. The arc-light is used principally for lighting large areas : for instance, Charing Cross station is lit by one form of arc-light, called the Brush ; Cannon Street station is lit by what is known as the Brockie lamp ; the space in front of the Royal Exchange is lit up by the Siemens arc-lamp ; King's Cross station is lit up by the Crompton plan ; and so on. A very brilliant arc-lamp at Paris, which attracted a great deal of attention, was called the Jasper light. But all arc-lamps play upon one string, similar to the plan I have just shown, viz., that when two pieces of carbon are maintained at a certain distance from each other, and electricity passed between them, great heat and brilliant light are the result. There are certain difficulties in arc-lamps which militate against their employment for domestic and internal use generally. The light is very intense ; the effect is irritating ; the ladies do not like it (and they are a powerful influence in this country), because it does not suit their complexion, nor their style of costume for evening wear : they have set their faces against it for internal illumination, and, that being so, it is all up with it. Now, the light that is going to supplant the arc light for domestic purposes is the incandescent light. The principle of the incandescent lamp is exactly the same as that I showed you in Mr. Becker's lamp, viz., that a suitable substance is inclosed in a glass bulb, from which the air has been extracted, and is brought to a high state of temperature by the passage through it of currents of electricity. The lamps illuminating this room are Mr. Edison's incandescent lamps, whose representative, Mr. Johnson, has been most indefatigable in his assistance for these lectures. The Edison lamp consists of a single curl, or loop, of a fine carbon filament (instead of platinum wire) placed in an exhausted glass bulb. The carbon is extremely thin—as thin as a human hair—but, in spite of its extreme tenuity, you see [knocking a lamp on the table] that concussion or shaking does not cause it to break, but it possesses great resilience, and vibrates like a steel spring ; and it is so refractory that it will stand electric currents of enormous strength. As I have said, the lamps before you are worked by electric currents generated by an Edison dynamo-machine on the Thames embankment, but each lamp is self-regulating and can be turned on and off by turning

a tap very like those used on gas-brackets. The stronger the current supplied to the lamp, the greater its heat and brilliancy; and when, by turning a handle in the instrument I have for the purpose, the strength of the current is increased, it forms a brilliant light in the glass tube, until the amount of current is greater than the carbon can stand, when it radiates a beautiful blue haze, which indicates that its end is near, and then it is broken (as you see), and the lamp goes out. I can easily replace the broken lamp by unscrewing it out of its socket, and placing a fresh one in its place, when at once all is in good order, and the light resumed. These lamps are water-tight as well as air-tight, and to prove this I will insert a lighted lamp into the little aquarium on the table, when you see that the globe is brilliantly lit up, and that the fish it contains show rather a sign of curiosity than discomfiture, and seem rather proud of their colors which are so distinctly brought out by the brilliancy of the light. Here I have a globe of colored water to show what brilliant effects can be produced. A good deal has been said about the dangers of electric lighting, and how careful we ought to be in its use, and there is no doubt that electricity is a very dangerous agent if you do not know how to use it. We have heard of the danger from fire through its use in theatres and houses, but I want to show you that, when I place a cambric pocket-handkerchief round a lamp, which I then break while electricity is going through it, no spark or fire of any kind occurs, but the lamp instantly goes out. There is also danger from wires coming in contact with each other, and in that case they short circuit the machine; they cause an increased strength of current to flow, producing heat, and in that manner setting fire to houses. To obviate this danger, "safety-catches" have been introduced by Mr. Edison. These safety-catches consist in the insertion of a very small piece of lead wire in the circuit, which is readily fusible, so that if the current becomes unnecessarily powerful, it passes through the lead wire, heats it to fusing-point, and so breaks down the section on which the "safety-catch" is placed, eliminating at once all danger. It does not affect any other lamps, as you see. When the fused safety-catch is replaced by a good one, the lamps which were broken down by its rupture become lighted up again. We have the means of regulating the lights now burning in the room. Here is an apparatus in connection with the machine at the engine-station, and, by moving the handle and inserting in the circuit a certain amount of resistance, I am able so to reduce the current flowing from the machine that a considerable lowering of the light takes place. On turning the handle back again, the former brilliancy returns. That shows the electric light in the latest stage of its perfection. We have a bright light now in this room, but no impure gases are given off by the electric light, and the air is not vitiated by it. The room is warm, but that warmth is due to the number of people present, and not to the heat produced by the elec-

tric light; though the electric light does, as I have said, generate heat to produce its effulgence. Many people talk of the electric light as being "cold" and cheerless. The light produced by the arc-lamp does look cold and cheerless; but the soft, delicious, incandescent lamp before you has just as soothing an effect upon the eye as the prettiest lamps or the pleasantest candle; and it has certainly removed all the objections that were previously raised to the electric light for internal illuminating purposes.

The next and last branch of my subject is the transmission of motive-power to a distance. I have shown you how currents of electricity are produced; also how they do work; how they produce electromagnetism; how they generate heat; how they produce light; and now I want to show you that the whole thing is reversible. If, by the exertion of mechanical power, currents of electricity can be produced, those very same currents of electricity can in their turn produce mechanical power. If, instead of receiving currents of electricity from the dynamo-machine on the Thames embankment, we transmitted currents of electricity to it, we should cause it to rotate, but in the reverse direction. I have here a small machine for the purpose of illustrating this to you; it is the invention of Mr. Griscom, who has supplied it to a large extent in America for turning sewing-machines. The wires from the hand dynamo-machine are now attached to the Griscom motor, and, when currents of electricity are generated by turning the handle of the dynamo, they are conveyed to the motor, and cause it to revolve with the high rapidity you see. It is surprising that such a tremendous momentum should be produced by so small a strength of electric current. The wires connecting the two machines in this instance are short, but the effect would have been practically the same had the machines been miles apart. By changing the wires, the direction in which the motor rotates is reversed, so that I not only get power transmitted, but can reverse its direction. In this case, as the electricity is generated by hand, its power is small; and, therefore, with my strength (which is only about one twelfth of a horse-power), I can stop the rotation of the motor; but, if steam-power were employed to generate the electricity, the power transmitted would be beyond my control in that sense. This motive-power was illustrated, in many different forms, at the Paris Exhibition; for instance, from the commencement of the Champs-Elysées to the exhibition building, a tram-car was propelled (sometimes at the rate of twenty-five miles an hour) upon rails laid down for the purpose, and, during the time that the exhibition was open, that car carried seventy-five to eighty thousand people, who were conveyed to or from the building by motive-power generated by steam in the exhibition and conveyed by wires to the farther extremity of the track. An electric railway will form part of the Electric Exhibition at the Crystal Palace, and among the proposals to be laid before Parliament next session is a project for

constructing an electric railway between Northumberland Avenue and Waterloo Station. Again, at the Paris Exhibition, an enterprising firm of agriculturists showed land-plowing by electricity, and, in fact, the application of electricity to innumerable useful purposes was illustrated—rock-boring, newspaper-printing, driving of sewing-machines, embroidery, leather-work, glass-cutting, wood-carving, lifts raised, ventilation assisted, etc. I am looking forward to the Crystal Palace Exhibition with great interest, to see how far these exhibits will be repeated. The exhibition will be well worth a visit; in fact, all exhibitions are worth visiting, for they excite interest, they induce every one, more or less, by generating curiosity, to add to his knowledge, they honestly stimulate national as well as individual competition, and they always result in the enlargement of the useful application of a power like that of electricity, because a man of one trade who sees electricity used in another trade can not resist thinking out whether it can not also be usefully applied to his own purposes. We sometimes hear electricity spoken of as a mysterious agency, and sometimes as a wild, untamed beast. It is only mysterious to the ignorant, and it is only untamed to the unskilled. I hope that the promise I made to you at first starting, that you would leave this room with a fair knowledge of how the electric light is produced, has been fulfilled, and I can only add that electricity will always prove an obedient slave to those who take the trouble to understand it; but it may prove, and it has proved, a very dangerous ally to the ignorant and the unskilled.

MODERN EXPLOSIVES.

By BENJAMIN VAUGHAN ABBOTT.

IS any one noting the loss of life and property by explosions? Can not some improved measures of protection be suggested? There is great increase in the number, variety, and potential energy of explosives, and they are causing a startling number of disasters; and these involve not only the proprietors who have the control, and the hands who do the work of the magazine, mine, quarry, factory, steamship, locomotive, in which the explosion occurs, but also the general public—by-standers, persons walking, riding, or lodging near, passengers by train or steamboat, carriers or purchasers of dangerous goods improperly packed, and many others. Recall a score of the more novel and peculiar cases of the season of 1881, those which represent the advance in this peril, and see if they do not indicate that more stringent regulation of the subject is demanded for public safety.

There was wide-spread excitement in August when British custom-

house officers discovered clock-work machines loaded with dynamite concealed in barrels of cement just imported from this country, and Irish revolutionary patriots in America avowed that they had sent them to be used against England, and that they hoped by similar devices to render English vessels unsafe and unprofitable. Many remembered the project of Thomassen, years ago, for blowing up in mid-ocean a vessel on which he had goods heavily insured, and wondered whether such plans could indeed be extended to the shipping of a whole nation. There were like alarms later. The officers of the Bothnia were naturally disturbed when two strangers prowled through her passage-ways and, a few moments afterward, the carpets over which they had passed burst into flames from some novel combustible smeared upon them. In Liverpool a second discovery was reported of dynamite cartridges concealed in bales of cotton received from America, and believed to be destined to destroy mills at Oldham. All these were merely alarms. More lately an explosion of dynamite on board the Glasgow steamer Severn is reported to have killed nine persons and injured forty-three, four of these fatally. These things have brought to public notice the want of any distinct, efficient law to punish the sending of explosives on board ship with the purpose of destroying her on her voyage. If an explosion occurs, if life or property is destroyed, the general laws against murder, piracy, or defrauding insurers, would probably apply. But suppose the infernal machine is detected before injury is done, so that the offender can be charged only with having sent it aboard. Is there any sufficient law against this? No doubt the practical danger is small. Aside from the hope that villains capable of forming such a plot are very few in number, it is well known that most of the cargo of ocean-bound steamers is received direct from responsible exporting houses, and a stranger could scarcely obtain access to their packing-rooms in order to conceal cartridges in their merchandise. Still there must always be some tons of miscellaneous parcels, and the ship-owners can know little or nothing of the senders of these. It must always be possible for a schemer, under pretense of taking passage, to send a trunk aboard containing an infernal machine. How could this be discovered? But difficulty of detection is no reason why the public should not have the protection of a severe law for cases which may be detected. Such laws as exist are designed rather to forbid concealing the character of explosives in order to avoid the ship-owner's objection to take them, or his demand of a higher freight on the score of the danger, than to prevent the heinous offense of plotting the destruction of the vessel. For example, in New York city the authorities discovered that hands on board the Havana steamship Saratoga were concealing gunpowder packed in fourteen fifty-pound cans (seven hundred pounds in all), underneath berths in state-rooms. On a canal-boat were found forty boxes, each marked "I. R. P.," believed to mean "Irish Revolutionary Par-

ty," and holding twenty-five tin cans, each containing a pound of gunpowder. Probably there was no intent in either case to injure vessel or passengers—the offender only desired to get his powder safely landed at the vessel's destination without paying duties or high freight charges. Present laws cover this species of fraud much better than they do the worse crime of plotting to destroy ship, crew, and passengers.

When explosions are mentioned, one naturally thinks first of gunpowder. Explosions in powder-factories in Maine and Missouri destroyed the entire building and killed, in one case one workman, in the other eleven. A similar disaster in Mexico destroyed a whole square, burying many families under the ruins, and about sixty bodies were recovered. Some mishap in firing the fog-gun at Bird Rocks Light-house, on the St. Lawrence, ignited a barrel of gunpowder near by, killing three persons. A Louisiana merchant, in his store, struck a match to light a cigarette, and a scintilla of the burning sulphur flew into a can containing twenty-five pounds of powder. The explosion demolished the building and stock of goods, killed the careless proprietor and injured two blameless by-standers. Now, gunpowder has been so long in use and is so familiarly known, that there ought to be an end of such carelessness as accounts like these indicate. Very rarely, a disaster by gunpowder occurs which may be called pure accident. In a room where drugs were ground in quantities, dust of sulphur, also of saltpeter, gradually settled on the beams, in corners and crevices, and in the various places where dust in such a work-room is wont to gather, and it was intermingled naturally with dust such as every breeze brings, supplying a modicum of carbon. The mixture was equivalent to gunpowder, and, when a workman dropped a lighted candle, the roof flew off in fragments. He was scarcely to blame. There is a "white gunpowder" about which a prudent person might make a mistake. But the majority of powder explosions are attributable to sheer carelessness. The trouble is that "familiarity breeds contempt"; yet how to induce greater care is a perplexing question.

Nitro-glycerine and dynamite have done their share of mischief. In Colorado, four out of five men, who were preparing a charge of nitro-glycerine for a mining blast, were killed by a premature discharge; and in Pennsylvania a magazine containing three hundred pounds of this substance exploded, doing immense damage. At Council Bluffs, just as the Garfield memorial exercises were closing, there was a fearful explosion of a car-load of blasting-powder, probably dynamite, which demolished the railroad company's buildings and nearly fifty of their cars, dug a hole in the ground forty-five feet across and fifteen feet deep, shattered buildings throughout the city and glass windows even in Omaha across the river, and made itself felt as far as Missouri Valley, twenty miles away. One can not judge from the brief

accounts given what are the precise causes of such disasters, but there is reason to believe that ignorance is prolific ; that many persons have only a vague knowledge of the qualities of nitro-glycerine, can not recognize it when they see it, and are not acquainted with the various forms in which it is compounded or with the peculiar dangers of handling it carelessly. Nitro-glycerine itself is a dense, yellowish liquid, but, in order to diminish the danger attending its use, fine earth, ground mica, sawdust, or some similar powder, is saturated with it, and thus the various blasting-powders known as dynamite, mica-powder, dualin, rend-rock, etc., are formed. These compounds can be transported with comparative safety. But the nitro-glycerine easily drains off from the powder and oozes from any crevice in the vessel in which the compound is kept. Drops of it thus bedewing the edges of a box may very easily be mistaken for oil escaping, and if workmen ignorantly endeavor to nail the box tighter or to open it for examination there will be a disastrous explosion. Several have occurred in past years in this way. The victims knew, no doubt, that nitro-glycerine (or the compounds) may be exploded by a blow (contact with fire is not needful), but they did not suspect that the innocent-looking oil was nitro-glycerine. Why should not youth be taught in the schools somewhat of the practical dangers of these substances which are coming into such common use? They would pursue the study with interest, especially if there were judicious experiments. A Missouri story is that a teacher confiscated a small metal box which a pupil was playing with in school hours, and, thinking it contained chewing-gum, tried to break it open with a hammer. It was a dynamite torpedo of the kind used on the railroad-track as a danger-signal, and large bits of it had to be cut out of the lady's cheek. Would it not have been well if she had known somewhat of the aspect of torpedoes? Was it not more important to the journeyman plumber who threw the lighted match into the pan of camphene, mistaking it for water, by which the great printing establishment of Franklin Square was burned some twenty-eight years ago, to know camphene by sight than to have memorized many of the matters prominent in a public-school course? Surely workmen, especially "raw hands" in establishments where these things are used, should be systematically instructed in advance, and the courts are now enforcing this principle. Two lawsuits were heard during 1880, where managers of mining companies introduced blasting-powder as a substitute for gunpowder, without specially instructing the workmen as to the change and the new precautions they ought to take. The workmen used the powder improperly, and some of them were badly hurt. The victims brought suit for damages, and the companies retorted that the disasters were due to carelessness of the men. Both courts said that the proprietors of mines have a right to introduce a more effective powder, but they are bound to give their men judicious instructions and cautions, and to furnish them with any implements or apparatus appro-

priate to diminish as much as possible the danger of using the new agent; and, for neglect of the superintendents to give these instructions, the proprietors were required in both cases to pay damages.

The importance of some education of the working classes on these matters is increased by the frequency with which new explosives are introduced. One, called "explosive jelly," was brought to notice early last summer. It is made by dissolving nitro-glycerine and gun-cotton in ether, and then evaporating the ether; and it is said to be the most powerful of the nitro-glycerine compounds, though it can be exploded only by a detonator, which fact diminishes danger. A novelty called "dynamoge" is mentioned in late European papers.

Folly of workmen solves many of this class of disasters. In Sawyer City, Pennsylvania, a gang of men digging a well were about to set a torpedo for blasting. The foreman, said to have been an intemperate man, hastily poured two quarts of nitro-glycerine into the shell, and then attempted to fit the cap to its place. It was tight, he gave it an angry blow with his fist, the charge exploded, and five men were killed, three others being badly hurt. Criminal use of dynamite has been detected in several cases. A Brooklyn man found a dynamite bomb-shell under the stoop of his house, apparently put there in the night by some enemy, and the fuse lighted; but a friendly rain-storm had extinguished the fuse. In Ohio a workman found a yellowish roll lying lengthwise on one of the rails of the Baltimore and Ohio road. He did not know what it was, but it was tested by the superintendent, and found to be dynamite in sufficient quantity to have blown any train to atoms. It was evidently placed to wreck an express train then nearly due. On the Great Northern Railway in Ireland the guard detected nine pounds of dynamite which a passenger was carrying for some unlawful purpose, and took it from him. In Central America, a merchant was murdered by a new and ingenious use of dynamite. The charge was placed in the large lock of his store-door, with the exploder arranged to be set off by the door-key. He was instantly killed on attempting to unlock the door. When such an attempt is successful, the laws are efficient to punish it. But in most of the States the laws are defective in regard to mere attempts or plots. The statute-books punish shooting at a person or administering poison, although he be not killed or even hurt; but, perhaps, say nothing about schemes fully as dangerous for destroying life or property by these explosives. Apparently the means are so novel that Legislatures have not had time to think of them. The advice to give instruction on these subjects to school-pupils and workmen should probably be extended to embrace the law-makers of the land.

There are curious infelicities in the laws as to carrying explosive powders about the country. Cities and towns very generally have ordinances which restrict carting them through the crowded streets, but

these do not apply to long journeys. Before railroad days it was well understood that Congress controlled carriage of dangerous articles by water, for to regulate navigation was early understood to be a duty of the Federal Government. But in those days nitro-glycerine was unknown, and the fulminates were little used. Hence both were ignored in the early laws of Congress regulating water-carriage of dangerous articles, which mentioned only gunpowder and acids, and the like. Recently it has been thought that the authority of Congress extends to railroad-trains running from State to State, for this is a branch of "commerce among the States." When Congress came, in 1866, to legislate as to carrying nitro-glycerine and its compounds, the law was made to apply equally to vessels, and to railroads extending from one State to another. But no one has noticed that the old laws as to gunpowder ought equally to be extended to through railroad-trains. Apparently there is no Federal law prescribing precautions for railroad-carriage of gunpowder across the country, and yet, according to the most advanced views, the States have not power to pass laws on the subject. Each State has, however, power to say how explosives shall be carried within her own boundaries ; and this leads to another infelicity, which is, that the law of the Union and of a State may clash. For example, United States law requires the blasting-powders made from nitro-glycerine, and the oil itself, to be packed and labeled in a peculiar way, when they are to be sent by rail from one State to another. The law of Colorado imposes restriction on nitro-glycerine, but, as amended last summer, for the convenience of the miners, it exempts dynamite and other powders. Now, if a train in Colorado should be wrecked by explosion of dynamite in the loading, the victims will not derive much comfort from being told that the offending keg did not come from the eastward States, and so was not subject to the United States rule, but was put aboard at Denver. Whatever restriction is needful ought to be imposed by Federal and State laws alike, and for short journeys as well as upon long.

The subject of dynamite is "a cloud with a silver lining"—the topic has its lighter aspects. One journal narrates that workmen, employed in blasting, left about a hundred pounds of dynamite exposed in an open box. Two cows of a neighboring farmer drew near, looked, smelled, tasted, and, finding that the compound had a saltish flavor, began to regale themselves heartily : in a moment those cows were staggering without heads. At a certain military post there was a mule who had "outlived his usefulness," also a commanding general who desired to experiment in instantaneous photography. The animal was placed in position before a camera, his forehead bearing a cotton bag containing six ounces of dynamite; the slide of the camera was supported by a fuse, and this fuse and the dynamite were connected in the same electrical circuit, by wires leading to a battery

placed at a safe distance. On pressing the key so as to send the electricity through the wires, both fuse and dynamite were fired simultaneously, and the camera slide fell so quickly after the mule's head vanished, that a good photograph was taken of the creature, standing headless, before its body had had time to fall. Shocking to the mule; but entertaining and instructive to the class of military students which assembled to witness the experiment. More shocking, perhaps, is a device reported from the Southwest, called "the torpedo-chicken." It looks like a chicken, and sits like one on the roost among live fowl. But when, at about midnight, the hand of the chicken-thief of the region grasps it, a catch is thrown out of place, a powerful spring moves, a hammer strikes a percussion cap, there is an explosion, and about four ounces of bird-shot are thrown in every direction. The finale is said to be that a dusky figure is seen running or limping down the alley, and a husky voice is heard: "Fo' de Lawd! but what has de white folks got hold of now?" The scientific accuracy of this description will be appreciated, when the reader learns that it is from the "Detroit Free Press." Evidently, here is a hint to inventors: what a variety of burglar-alarms, thief-catchers, and other detective devices may be developed! The account circulated a year or two ago, of the newly invented trunk, fitted with pockets of nitro-glycerine at the corners, which might operate by way of reward of merit for any super-active baggage-smasher, is but a forerunner.

One would suppose that the various forms of ordnance would be managed with peculiar skill and care, yet they give rise to many disasters. A workman intrusted with packing seventy-five thousand percussion-caps in boxes handled them roughly; they exploded, and he was killed. Another, who was charging a rocket in the ordnance fulminate-room at a navy-yard, was killed, his companions severely hurt, and the inner walls of the building demolished by a premature discharge. Several men were badly hurt by a like disaster, in the course of loading cartridges with fulminate, at the factory of the Winchester Repeating Arms Company, in New Haven. A bomb-shell was sent among a quantity of old iron to a foundry in Brooklyn to be melted; but it was loaded, and within a few minutes after it was thrown into the furnace there was a disastrous explosion. The saddest case of the kind narrated during the summer is that in which Lieutenants Edes and Spalding lost their lives at Newport. They were sent to plant a torpedo, and full instructions were given them as to the precautions needful; but, through some error or neglect on their part, the electrical circuit was prematurely closed, and the torpedo fired while they were yet in their boat above it.

Not half of the casualties reported during the season have been mentioned, nor has anything been said of the numerous fatalities from bursting of kerosene lamps and cans, of leaky gas-pipes, steam-boilers, revolving stones, inflammable dust, and other things not intended as ex-

plosives. Yet, surely ground has been shown for the suggestion that increased attention should be bestowed upon the improvement of the laws, and the instruction of the common people, relative to the modern explosives.

THE GERM THEORY.*

By Professor LOUIS PASTEUR.

GENTLEMEN: I had no intention of addressing this admirable Congress, which brings together the most eminent medical men in the world, and the great success of which does so much credit to its principal organizer, Mr. MacCormac. The good-will of your esteemed president has decided otherwise. How could one, in fact, resist the sympathetic words of that eminent man, whose goodness of heart is associated in no small degree with great oratorical ability? Two motives have brought me to London. The first was to gain instruction, to profit by your learned discussions; and the second was to ascertain the place now occupied in medicine and surgery by the germ theory. Certainly I shall return to Paris well satisfied. During the past week I have learned much. I carry away with me the conviction that the English people are a great people; and, as for the influence of the new doctrine, I have been not only struck by the progress it has made, but by its triumph. I should be guilty of ingratitude and of false modesty, if I did not accept the welcome I have received among you, and in English society, as a mark of homage paid to my labors during the past five-and-twenty years upon the nature of ferments—their life and their nutrition, their preparation in a pure state by the introduction of organisms (*ensemencement*) under natural and artificial conditions—labors which have established the principles and the methods of *microbie* (microbism), if the expression is allowable. Your cordial welcome has revived within me the lively feeling of satisfaction I experienced when your great surgeon, Lister, declared that my publication in 1857, on milk-fermentation, had inspired him with his first ideas on his valuable surgical method. You have reawakened the pleasure I felt when our eminent physician, Dr. Davaine, declared that his labors upon charbon (splenic fever or malignant pustule) had been suggested by my studies on butyric fermentation and the vibrion which is characteristic of it. Gentlemen, I am happy to be able to thank you by bringing to your notice a new advance in the study of microbie as applied to the prevention of transmissible diseases—diseases which, for the most part, are fraught with terrible consequences, both for man and domestic animals. The subject of my com-

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munication is vaccination in relation to chicken-cholera and splenic fever, and a statement of the method by which we have arrived at these results—a method the fruitfulness of which inspires me with boundless anticipations. Before discussing the question of splenic-fever vaccine, which is the most important, permit me to recall the results of my investigations of chicken-cholera. It is through this inquiry that new and highly-important principles have been introduced into science concerning the virus or contagious quality of transmissible diseases. More than once, in what I am about to say, I shall employ the expression virus-culture, as formerly, in my investigations on fermentation, I used the expressions, the culture of milk-ferment, the culture of the butyric vibrion, etc. Let us take, then, a fowl which is about to die of chicken-cholera, and let us dip the end of a delicate glass rod in the blood of the fowl with the usual precautions, upon which I need not here dwell. Let us then touch, with this charged point, some *bouillon de poule*, very clear, but first of all rendered sterile under a temperature of about 115° Centigrade, and under conditions in which neither the outer air nor the vases employed can introduce exterior germs—those germs which are in the air, or on the surface of all objects. In a short time, if the little culture-vase is placed in a temperature of 25° to 35°, you will see the liquid become turbid, and full of tiny microbes, shaped like the figure 8, but often so small that, under a high magnifying power, they appear like points. Take from this vase a drop as small as you please—no more than can be carried on the point of a glass rod as sharp as a needle—and touch with this point a fresh quantity of sterilized *bouillon de poule* placed in a second vase, and the same phenomenon is produced. You deal in the same way with a third culture-vase, with a fourth, and so on to a hundred, or even a thousand, and invariably, within a few hours, the culture-liquid becomes turbid and filled with the same minute organisms. At the end of two or three days' exposure to a temperature of about 30° Cent., the thickness of the liquid disappears, and a sediment is formed at the bottom of the vase. This signifies that the development of the minute organism has ceased—in other words, all the little points which caused the turbid appearance of the liquid have fallen to the bottom of the vase, and things will remain in this condition for a longer or shorter time, for months even, without either the liquid or the deposit undergoing any visible modification, inasmuch as we have taken care to exclude the germs of the atmosphere. A little stopper of cotton sifts the air which enters or issues from the vase through changes of temperature. Let us take one of our series of culture preparations—the hundredth or the thousandth, for instance—and compare it, in respect to its virulence, with the blood of a fowl which has died of cholera; in other words, let us inoculate under the skin ten fowls, for instance, each separately with a tiny drop of infectious blood, and ten others with a similar quantity of the liquid in which

the deposit has first been shaken up. Strange to say, the latter ten fowls will die as quickly, and with the same symptoms, as the former ten; the blood of all will be found to contain after death the same minute infectious organisms. This equality, so to speak, in the virulence both of the culture preparation and of the blood is due to an apparently futile circumstance. I have made a hundred culture preparations—at least, I have understood that this was done—without leaving any considerable interval between the impregnations. Well, here we have the cause of the equality in the virulence. Let us now repeat exactly our successive cultures, with this single difference, that we pass from one culture to that which follows it—from the hundredth to, say, the hundred and first, at intervals of a fortnight, a month, two months, three months, or ten months. If, now, we compare the virulence of the successive cultures, a great change will be observed. It will be readily seen, from an inoculation of a series of ten fowls, that the virulence of one culture differs from that of the blood, and from that of a preceding culture, when a sufficiently long interval elapses between the impregnation of one culture with the microbe of the preceding. More than that, we may recognize, by this mode of observation, that it is possible to prepare cultures of varying degrees of virulence. One preparation will kill eight fowls out of ten, another five out of ten, another one out of ten, another none at all, although the microbe may still be cultivated. In fact, what is no less strange, if you take each of these cultures of attenuated virulence as a point of departure, in the preparation of successive cultures, and without appreciable interval in the impregnation, the whole series of these cultures will reproduce the attenuated virulence of that which has served as the starting-point. Similarly, where the virulence is null, it produces no effect. How, then, it may be asked, are the effects of these attenuating virulences revealed in the fowls? They are revealed by a local disorder, by a morbid modification more or less profound in a muscle, if it is a muscle which has been inoculated with the virus. The muscle is filled with microbes which are easily recognized, because the attenuated microbes have almost the bulk, the form, and the appearance of the most virulent microbes. But why is not the local disorder followed by death? For the moment let us answer by a statement of facts. They are these: the local disorder ceases of itself more or less speedily, the microbe is absorbed and digested, if one may say so, and, little by little, the muscle regains its normal condition. Then the disease has disappeared. When we inoculate with the microbe, the virulence of which is null, there is not even local disorder, the *naturæ medicatrix* carries it off at once; and here, indeed, we see the influence of the resistance of life, since this microbe, the virulence of which is null, multiplies itself. A little further, and we touch the principle of vaccination. When the fowls have been rendered sufficiently ill by the attenuated virus which the vital resistance has arrested in its de-

velopment, they will, when inoculated with virulent virus, suffer no evil effects, or only effects of a passing character. In fact, they no longer die from the mortal virus, and, for a time sufficiently long, which in some cases may exceed a year, chicken-cholera can not touch them, especially under the ordinary conditions of contagion which exist in fowl-houses. At this critical point of our manipulation—that is to say, in this interval of time which we have placed between two cultures, and which causes the attenuation—what occurs? I shall show you that, in this interval, the agent which intervenes is the oxygen of the air. Nothing more easily admits of proof. Let us produce a culture in a tube containing very little air, and close this tube with an enameler's lamp. The microbe, in developing itself, will speedily take all the oxygen of the tube and of the liquid, after which it will be quite free from contact with oxygen. In this case, it does not appear that the microbe becomes appreciably attenuated, even after a great lapse of time. The oxygen of the air, then, would seem to be a possible modifying agent of the virulence of the microbe of chicken-cholera—that is to say, it may modify more or less the facility of its development in the body of animals. May we not be here in presence of a general law applicable to all kinds of virus? What benefits may not be the result? We may hope to discover in this way the vaccine of all virulent diseases; and what is more natural than to begin our investigation of the vaccine of what we, in French, call charbon; what you, in England, call splenic fever; and what, in Russia, is known as the Siberian pest; and, in Germany, as the Milzbrand? In this new investigation I have had the assistance of two devoted young *savants* —MM. Chamberland and Roux. At the outset we were met by a difficulty. Among the inferior organisms, all do not resolve themselves into those corpuscle-germs which I was the first to point out as one of the forms of their possible development. Many infectious microbes do not resolve themselves, in their cultures, into corpuscle-germs. Such is equally the case with beer-yeast, which we do not see develop itself usually in breweries, for instance, except by a sort of scissiparity. One cell makes two or more, which form themselves in wreaths; the cells become detached, and the process recommences. In these cells real germs are not usually seen. The microbe of chicken-cholera and many others behave in this way, so much so that the cultures of this microbe, although they may last for months without losing their power of fresh cultivation, perish finally like beer-yeast which has exhausted all its aliments. The anthracoid microbe in artificial cultures behaves very differently. In the blood of animals, as in cultures, it is found in translucid filaments more or less segmented. This blood or these cultures freely exposed to air, instead of continuing according to the first mode of generation, show, at the end of forty-eight hours, corpuscle-germs distributed in series more or less regular along the filaments. All around these corpuscles matter is absorbed, as I have

represented it formerly in one of the plates of my work on the diseases of silk-worms. Little by little all connection between them disappears, and presently they are reduced to nothing more than germ-dust. If you make these corpuscles germinate, the new culture reproduces the virulence peculiar to the thready form which has produced these corpuscles, and this result is seen even after a long exposure of these germs to contact with air. Recently we discovered them in pits in which animals, dead of splenic fever, had been buried for twelve years, and their culture was as virulent as that from the blood of an animal recently dead. Here I regret extremely to be obliged to shorten my remarks. I should have had much pleasure in demonstrating that the anthracoid germs in the earth of pits in which animals had been buried are brought to the surface by earth-worms ; and that, in this fact, we may find the whole etiology of disease, inasmuch as the animals swallow these germs with their food. A great difficulty presents itself when we attempt to apply our method of attenuation by the oxygen of the air to the anthracoid microbes. The virulence establishing itself very quickly, often after twenty-four hours, in an anthracoid germ which escapes the action of the air, it was impossible to think of discovering the vaccine of splenic fever in the conditions which had yielded that of chicken-cholera. But was there, after all, reason to be discouraged? Certainly not ; in fact, if you observe closely, you will find that there is no real difference between the mode of the generation of the anthracoid germ by scission and that of chicken-cholera. We had, therefore, reason to hope that we might overcome the difficulty which stopped us by endeavoring to prevent the anthracoid microbe from producing corpuscle-germs, and to keep it in this condition in contact with oxygen for days, and weeks, and months. The experiment fortunately succeeded. In the ineffective (*neutre*) *bouillon de poule* the anthracoid microbe is no longer cultivable at 45° Cent. Its culture, however, is easy at 42° or 43°, but in these conditions the microbe yields no spores. Consequently it is possible to maintain in contact with the pure air, at 42° or 43°, a *mycélienne* culture of bacteria entirely free of germs. Then appear the very remarkable results which follow: In a month or six weeks the culture dies—that is to say, if one impregnates with it fresh *bouillon*, the latter is completely sterile. Up to that time life exists in the vase exposed to air and heat. If we examine the virulence of the culture at the end of two days, four days, six days, eight days, etc., it will be found that long before the death of the culture the microbe has lost all virulence, although still cultivable. Before this period it is found that the culture presents a series of attenuated virulences. Everything is similar to what happens in respect to the microbe in chicken-cholera. Besides, each of these conditions of attenuated virulence may be reproduced by culture ; in fact, since the charbon does not operate a second time (*ne récidive pas*), each of our attenuated anthracoid microbes constitutes

for the superior microbe a vaccine—that is to say, a virus capable of producing a milder disease. Here, then, we have a method of preparing the vaccine of splenic fever. You will see presently the practical importance of this result, but what interests us more particularly is to observe that we have here a proof that we are in possession of a general method of preparing virus vaccine based upon the action of the oxygen and the air—that is to say, of a cosmic force existing everywhere on the surface of the globe. I regret to be unable, from want of time, to show you that all these attenuated forms of virus may very easily, by a physiological artifice, be made to recover their original maximum virulence. The method I have just explained of obtaining the vaccine of splenic fever was no sooner made known, than it was very extensively employed to prevent the splenic affection. In France we lose every year by splenic fever animals of the value of 20,000,000 francs. I was asked to give a public demonstration of the results already mentioned. This experiment I may relate in a few words. Fifty sheep were placed at my disposition, of which twenty-five were vaccinated. A fortnight afterward the fifty sheep were inoculated with the most virulent anthracoid microbe. The twenty-five vaccinated sheep resisted the infection ; the twenty-five unvaccinated died of splenic fever within fifty hours. Since that time my energies have been taxed to meet the demands of farmers for supplies of this vaccine. In the space of fifteen days we have vaccinated, in the departments surrounding Paris, more than 20,000 sheep, and a large number of cattle and horses. If I were not pressed for time, I should bring to your notice two other kinds of virus attenuated by similar means. These experiments will be communicated by-and-by to the public. I can not conclude, gentlemen, without expressing the great pleasure I feel at the thought that it is as a member of an international medical congress, assembled in England, that I make known the most recent results of vaccination upon a disease more terrible, perhaps, for domestic animals than small-pox is for man. I have given to vaccination an extension which science, I hope, will accept as a homage paid to the merit and to the immense services rendered by one of the greatest men of England, Jenner. What a pleasure for me to do honor to this immortal name in this noble and hospitable city of London !

DEAN SWIFT'S DISEASE.

By Dr. BUCKNILL, F. R. S.

DURING the past autumn I received a letter from a gentleman engaged in literary work, requesting my opinion on the "mysterious disease" of the great author and wit whose name distinguishes this paper. My interlocutor particularly wished to know whether the

sane part of Swift's life was likely to have been in any way affected by the latent presence of insanity; whether a correct diagnosis was possible; whether parallel cases were on record; and, finally, whether a surfeit of green fruit, at the age of twenty-three years, was capable of resulting in the absolute fatuity from which the patient suffered at seventy-five.

This questioning has stimulated me to an investigation which I had thought was already threadbare, but which I found full of interest; and when I say that, upon weighing the evidence, it will probably be acknowledged that Jonathan Swift's mysterious disease was an instance of that curious form of disease, labyrinthine vertigo, or le maladie de Ménière, the knowledge of which is one of the most recent triumphs of pathological research directed by physiological experiment, it will scarcely be thought that it was needless to reopen a controversy in which already everything had been said which ought to have been said, and not a little which ought not to have been said.

When Dr. Beddoes suggested that Swift's ailments and his conduct toward women were due to dissolute habits in youth, Sir Walter Scott replied that, "until medical authors can clearly account for and radically cure the diseases of their contemporary patients, they may readily be excused from assigning dishonorable causes for the disorders of the illustrious dead." But, if Dr. Beddoes were unquestionably wrong in making such a suggestion without evidence, Sir Walter was scarcely right in making his retort too general; for, if medical opinions respecting the states of mind of persons who have departed this life must be forbidden until medical men can insure the radical cure of diseases, not only will much valuable evidence respecting the validity of wills be excluded, but the science of pathology itself, depending upon the history of diseases and verified by observations made after death, must be interrupted until an event which seems impossible has taken place.

Whether the causes of disease are or are not dishonorable, and whether the subjects of them are or are not illustrious, has nothing to do with the scientific question; and the often-quoted sneer of Swift's greatest biographer at the medical profession seems, when examined, as silly as general sarcasm usually is. Undeterred by such sarcasm, an eminent medical man did investigate the causes for the disorders of the illustrious dead in a work which he modestly called an essay, published in 1849, and entitled "The Closing Years of Dean Swift's Life," etc., by W. R. Wilde, M. R. I. A., F. R. C. S. This little work, marked by the excellences of careful research, sound reasoning, moderate opinions and fair conclusions, would have rendered further discussion needless if medical science had stood still since its publication; but the advances made in medical psychology during the last thirty-two years might give us some excuse for reconsideration even if Ménière

had never made his discovery of a definite form of disease previously unrecognized, which appears to conform in all important points with the life-long disease of the illustrious dean.

Even in Swift's latest biography, or rather that fragment of one which so strongly makes us feel that touch of the vanished hand of the most appreciative critic of men of letters, the late John Forster's charming volume, the author speaks of Swift's giddiness and deafness, not as symptoms of one disorder, but as "two life-long enemies," and it is a curious enough fact that Swift himself attributed the origin of these two enemies to different causes, operating at different periods. In a letter to Mrs. Howard in 1727 he writes: "About two hours before you were born I got my *giddiness* by eating a hundred golden pippins at a time at Richmond; and when you were four years and a quarter old, bating two days, having made a fine seat further in Surrey, where I used to read, there I got my *deafness*, and these two friends, one or other, have visited me one or other every year since; and, being old acquaintances, have now thought fit to come together." Mrs. Howard having been born in 1690, the date of the deafness given in this letter would be 1694, when Swift was twenty-seven years old. But in a passage quoted by Forster, page 48, Swift wrote: "In England before I was twenty I got a cold, which gave me a deafness that I could never clear myself of . . . my left ear has never been well since."—April 30, 1737.

One can not but concur in Johnson's remark on the above, that "the original of diseases is commonly obscure, and almost every school-boy eats as much fruit as he can get, without inconvenience." But it may also be remarked that if Swift had been "a contemporary patient," although we might not have effected a radical cure of his disease, we should at least have understood enough of its origin and nature to have saved him from tormenting himself by a life-long abstinence from fruit, of which he was passionately fond, under the belief that it had caused and continued to excite his disease by inducing that "coldness of stomach to which he attributed his vertigo and its accompanying sickness."

In a letter of 1708 he says that, "I was through a long time pursued by a cruel illness that seized me at fits and hindered me from pursuing any business." It is possible that this illness was but a return of the dangerous colic from which he suffered in 1696; and it is not until 1710 to 1713, and while residing in London, that he describes in some detail the symptoms of his life-long complaint in his "Journal to Stella." The most descriptive passage is perhaps the one dated October 31, 1710:

"This morning, sitting in my bed, I had a fit of *giddiness;* the room turned round for about a minute, and then it went off, leaving me *sickish*, but not very. I saw Dr. Cockburn to-day, and he promises to send me the pills that did me good last year; and likewise has

promised me an oil for my *ears*, that he has been making for that ailment for somebody else."

A fit of giddiness, with sickness and ear-disease, is not this labyrinthine vertigo?

On different days in *January*, 1711, he writes:

"I had an ugly fit in my chamber last night. . . . My head is not in order, and yet is not absolutely ill; but giddyish, and makes me listless. . . . One fit shakes me a long time."

February 1st.—"I walked into the City to dine, but I walked plaguy carefully, for fear of sliding against my will."

April 18th.—"I did not go to the House of Commons about the yarn: my head was not well enough. I know not what is the matter. It has never been thus before; two days together giddy from morning till night, and I totter a little, but can make a shift to walk."

In *May:* "I do not totter as I did, but walk firm as a rock, only once or twice for a minute."

September 1st, he notes an important peculiarity, distinguishing cerebral from stomachic vertigo: "My head is pretty well; only a sudden turn at any time makes me feel giddy for a moment, and sometimes it feels very stuffed."

The journals of October show that he distinguished ordinary from vertiginous headache: "My head has ached a little in the evening, but it is not of the true giddy sort, so I do not much value it. . . . I had a little turn in my head this morning, which, though it did not last above a minute, yet being of the true sort, has made me as weak as a dog all this day."

During the years of residence in London which embrace the period of the "Journal to Stella," his other enemy, deafness, is only referred to incidentally, as when he compares it to that of the Lord Treasurer; but, after his return to Ireland, his deafness becomes sufficiently severe to make him complain.

In 1720 he writes, "What if I should add that once in five or six weeks I am deaf for three or four days?"

In 1724 he writes, "I have been this month past so pestered with a return of the *noise and deafness* in my ears that I had not the spirit to perform the common offices of life." Subsequently, in the same year, "My deafness has left me above three weeks, and therefore I expect a visit from it soon." It was evidently periodic and paroxysmal, like the giddiness.

He complains in another letter of an old vexatious disorder of a deafness and *noise* in the ears. In 1727, in a letter to Sheridan, he says that his deafness is worse than it ever before had been, and that it is accompanied by giddiness and tottering. "I believe," says he, "that this giddiness is the disorder which will at last get the better of me." And again, "I walk like a drunken man, and am deafer than ever you knew me."

In 1728, in "about eight months," says Wilde, "he had half a dozen attacks of the giddiness and sickness, each of which lasted about three weeks." But in 1731 he wrote to Mr. Gay, "The giddiness I was subject to, instead of coming seldom and violent, now constantly attends me more or less, though in a more peaceable manner, yet such as will not qualify me to live among the young and healthy." In 1736, writing to Pope, "years and infirmities have quite broke me. I mean that *continual* disorder in my head." In 1737, to Alderman Barker, "I am forced to tell you my health is much decayed; my deafness and giddiness more frequent; spirits I have none left; my memory is almost gone."

Long before, however, these symptoms had commenced. Impairment of memory he complained of as early as 1713, after the attack of shingles; and later on in the same year he speaks of his horrible melancholy changing into dullness, and from thenceforth increasing irritability of temper and mental depression are traceable throughout his history and correspondence. Not that he was at any time really of unsound mind or incapable; for, when in 1737, in the Bettesworth affair, a gratifying address was presented to him, it is recorded that "when this paper was delivered Swift was in bed, giddy and deaf, having been some time before seized with one of his fits; but he dictated an answer in which there is all the dignity of habitual pre-eminence and all the resignation of humble piety."

The above quotations are but a selection from a far greater number of references which might be made to Swift's letters and journals, affording conclusive evidence, as I venture to think, that he suffered from twenty years of age from the disease, whose characteristic symptoms are, "that the patient is suddenly seized with vertigo and a feeling of nausea or positive sickness, with great constitutional depression and faintness. Usually the giddiness comes on simultaneously with ringing or buzzing in one or, it may be, both ears."—*Ferrier.*

It has this year been pointed out by Féré, in the "Revue de Médecine," that there are two forms of the disease to be recognized, "une forme grave avec état vertigineux à peu près permanent interrompu par les paroxysmes, et une forme moins fâcheuse, constituée par des accès séparés par des périodes de santé parfaite. . . . Dans la forme bénigne [of which Swift's was an example] les accès ne se produisent quelquefois qu'à des distances très éloignées. E. Ménière cite une malade qui eut une rémission de onze mois. Pendant ces périodes d'accalmie, la surdité persiste avec une intensité variable, et elle s'accompagne souvent des sensations subjectives intermittentes de l'ouïe. La maladie elle-même dure tant que la surdité n'est pas absolue."

Up to the date to which we have traced the progress of the disease, it appears to have been purely a physical malady, with no mental symptoms, unless some degree of loss of memory can be so called.

Swift, indeed, complains bitterly of the impairment, as if memory were gone, and in his declining years of age and sickness it may have been a dull function compared with the brilliant faculty he once possessed. But clearly the memory was still serviceable which enabled him to compose, with wonderful vivacity, even such poetry as that outburst against political and social corruption—"The Legion Club"—which Jeffrey thinks "deserving of attention as the most thoroughly animated, fierce, and energetic of all Swift's metrical compositions; and though the animation be altogether of a ferocious character, and seems occasionally to verge upon absolute insanity, there is still a force and a terror about it which redeems it from ridicule, and makes us shudder at the sort of demoniacal inspiration with which the malison is vented." This poem, written in 1736, was his last work; its appreciation by his most hostile critic will show how little he suffered from loss of any mental faculty when he wrote it. That disease and grief had made him irritable and passionate, and often desponding, is clear enough from his correspondence and the accounts of him which have come down to us; but that there was any failure of mind this "Legion Club" fully disproves; and, if fiercely expressed hatred is any evidence that an author is on the verge of insanity, Jeffrey must have been curiously insensible to the testimony he was bearing against his own soundness of mind in his criticism of the greater master of his own art.

Between 1736, when Swift wrote "The Legion Club," and 1741, when the outbreak of insanity really took place, there can be no doubt that he passed through a period of great wretchedness and depression—he was "miserably ill." He had lost to a great extent two of his senses, for he was deaf and his eye-sight failed; his dearest friends had died before him, and his public sympathies were constantly outraged.

In 1738 he wrote to Alderman Barker: "I have for almost three years past been only the shadow of my former self, with years of sickness and rage against all public proceedings, especially in this miserably oppressed country. I have entirely lost my memory, except when it is aroused by perpetual subjects of vexation."

Two years later he wrote the following pathetic letter to his old friend Mrs. Whiteway:

"I have been very miserable all night, and to-day extremely deaf and full of pain. I am so stupid and confounded that I can not express the mortification I am under, both of body and mind. All I can say is that I am not in torture, but I daily and hourly expect it. Pray let me know how your health is, and your family. I hardly understand one word I write. I am sure my days will be very few; few and miserable they must be. I am for these few days yours entirely,

J. Swift.

"If I do not blunder it is Saturday."

A very pitiful state this period of becoming insane, and yet not having become so. But even at this late date one can not recognize the invasion of mental disease. Misery and despondency there was, more than enough, but not madness, unless Job was mad. But Swift was rapidly tending toward madness, and he knew it, for strong forebodings of insanity, which are not common, existed in him in a remarkable degree. Sir Walter Scott says that "his first state was that of violent and furious lunacy"; but Sir William Wilde points out that all the biographers have had no other sources of information as to the outbreak and history of his insanity than two letters; one from Mrs. Whiteway, and one from his cousin, Mr. Deane Swift.

Mrs. Whiteway wrote November 22, 1742, as follows, omitting some expressions of feeling:

"I was the last person whom he knew, and when that part of his memory failed he was so outrageous at seeing anybody that I was forced to leave him, nor could he rest for a night or two after seeing any person. He walked ten hours a day, would not eat or drink if his servant staid in the room. His meal was served ready cut, and sometimes it would be an hour on the table before he would touch it, and then eat it walking. About six weeks ago, in one night's time his left eye swelled as large as an egg, and the lid, Mr. Nicholls [his surgeon] thought would mortify, and many large boils appeared on his arms and body. The torture he was in is not to be described. Five persons could scarce hold him, for a week, from tearing out his own eyes; and for near a month he did not sleep two hours in twenty-four. Yet a moderate appetite continued; and, what is more to be wondered at, the last day of his illness he knew me perfectly well, took me by the hand, called me by my name, and showed the same pleasure as usual in seeing me. I asked him if he would give me a dinner? He said, 'To be sure, my old friend.' Thus he continued that day, and knew the doctor and surgeon and all his family, so well that Mr. Nicholls thought it possible he might return to a share of understanding, so as to be able to call for what he wanted, and to bear some of his old friends to amuse him. But alas! this pleasure to me was but of short duration; for the next day or two it was all over, and proved to be only pain that had roused him. He is now free from torture, his eye almost well, very quiet, and begins to sleep, but can not without great difficulty be prevailed upon to walk a turn about his room; and yet in this way, the physicians think, he may hold out for some time."

The only other authentic account from personal knowledge is contained in the letter of Mr. Deane Swift to Lord Orrery, dated April 4, 1744. After stating that a thousand stories of the illness had been invented and imposed upon the world, he proceeds to state some facts witnessed by himself:

"On Sunday the 17th of March, as he sat in his chair, upon the

housekeeper removing a knife from him as he was going to catch at it, he shrugged his shoulders, and rocking himself, he said, 'I am what I am. I am what I am'; and about six minutes afterward repeated the same words two or three times over. Sometimes he will not utter a syllable, at other times he will speak incoherent words; but he never yet, as far as I could hear, talked nonsense, or said a foolish thing. About four months ago he gave me great trouble. He seemed to have a mind to talk to me. In order to try what he would say, I told him I came to dine with him, and immediately his housekeeper, Mrs. Ridgeway, said, 'Won't you give Mr. Swift a glass of wine, sir?' he shrugged his shoulders, just as he used to do when he had a mind that a friend should not spend the evening with him. Shrugging his shoulders, your lordship may remember, was as much as to say, 'You'll ruin me in wine.' I own I was scarce able to bear the sight. Soon after he again endeavored, with a good deal of pain, to find words to speak to me; at last, not being able, after many efforts, he gave a heavy sigh, and I think was afterward silent. This puts me in mind of what he said about five days ago. He endeavored several times to speak to his servant [now and then he calls him by his name]; at last, not finding words to express what he would be at, he said, 'I am a fool.' Not long ago the servant took up his watch that lay upon the table, to see what o'clock it was; he said, 'Bring it here,' and when it was brought, he looked very attentively at it. Some time ago the servant was breaking a large, stubborn coal, he said, 'That's a stone, you blockhead.' In a few days, or some very short time after guardians had been appointed for him, I went into his dining-room, where he was walking; I said something to him very insignificant, I know not what, but, instead of making any kind of answer to it, he said, 'Go, go,' pointing with his hand to the door, and immediately afterward, raising his hand to his head, he said, 'My best understanding,' and so broke off abruptly, and walked away."

These two letters are stated by Sir William Wilde to be the only account of the last three years of Swift's life that has come down to us. He died October 19, 1745, in the seventy-eighth year of his age. His death, according to Lord Orrery, being easy, without the least pang or convulsion; but according to Faulkner, being one of "great agony, with strong convulsive fits" for thirty-six hours before. The only record of the autopsy which was made is that Mr. Whiteway "opened the skull, and found much water in the brain." A more interesting record, however, remains in the plaster cast of Swift's head. Of this Sir Walter Scott says that "the expression is most unequivocally maniacal, and one side of the mouth horribly contorted downward as if in pain." But Sir William Wilde, whose observation we greatly prefer in such a matter, says: "The expression is remarkably placid, but there is an evident drag on the left side of the mouth, exhibiting a paralysis of the facial muscles to the right side. Upon the

back of the cast are two lines of writing, greatly defaced, of which this much can still be read: 'Dean Swift, taken off his * * * * the night of his burial, and the f * * * * one side larger than the other in nature * * Opened before * * * The mould is in pieces.'" A deep indentation, says Wilde, shows where the calvarium had been sawn; and accurately corresponds with the division of the skull found in Swift's coffin in 1835. On the same excellent authority we know that the cast of the interior of Swift's skull is remarkable as showing the enormous development of the vessels within the cranium, the very small anterior lobes, the great size of the glandulæ Pacchioniæ, the exceedingly small cerebellum, a natural formation as may be seen by the very low position of the tentorium, the immense size of the posterior and middle lobes, particularly the former, and the absence of any appearance of disease in the anterior lobes, as far at least as this cast of the interior of the skull is capable of demonstrating.

Swift of course was not exempt from intercurrent diseases, the most important of which appear to have been a severe colic in 1696, which brought him to extremity, "so that all despaired of my life, and the newspapers reported me dead"; an attack of herpes zoster of the left neck and shoulder, with its atrocious after-pains, in 1712; and a severe attack of ague in 1720, which lasted a whole year. But these maladies appear to have passed away without permanent injury, and it is to the cold which, before he was twenty, gave him a deafness and an ear "which has never been well since," to which we must look as the origin of his physical and ultimately of his mental miseries, and which made him often describe himself as

"Vertiginosus, inops, surdus, male gratus amicis."

He does not appear ever to have guessed that his vertigo was due to the state of the auditory organ, nor indeed did any physician ever suspect that such was the case in any one suffering from ear-giddiness, until, led to reflect on the subject by Fleurens's experiments on the semicircular canals of pigeons and rabbits, Ménière recognized the causal connection in 1861. The paroxysmal nature of the affection, with long intervals of immunity, is well marked in Swift's case, although it would appear from a quotation made by Forster, p. 253, from one of his note-books, that the fits were pretty frequent, the reference to fits in his journal and correspondence only applying to the more serious occasions. The quotation is as follows:

"1708. *Nov.*—From 6th to 16, often giddy. G^{d} help me. So to 25 less. 16, Brandy for giddiness 2*s.* Br^{dy} 3^{d}. *Dec.* 5.—Horribly sick. 12*th.*—Much better, thank God and M. D.'s prayers. 16*th.*—Bad fit at Mrs. Barton's. 24. Better; but dread a fit. Better still to the end. 1709, *Jan.* 21*st.*—An ill fit but not to excess. 29. Out of order. 31. Not well at times. *Feb.* 7.—Small fit abroad. Pretty well to the end. *March.*—Headache frequent. *April* 2*nd.*—Small

giddy fit and swimming in the head. M. D. and God help me. *August.*—Sick with giddiness much. 1710. *Jan.*—Giddy. *March.*—Sadly for a day. 4*th.* Giddy from 4th. 14*th.*—Very ill. *July.*—Terrible fit. G[d] knows what may be the event. Better towards the end."

It is true that the paroxysms were not so numerous as those of most other cases of the disease which are on record, and also that the deafness never became absolute, and therefore that the disease never ceased. It increased in intensity as life advanced, until it confined him to his chamber for weeks at a time. It is also to be remarked that a slight degree of vertigo caused great constitutional disturbance. "I had a little turn in my head this morning, which, though it did not last above a moment, yet, being of the true sort, has made me as weak as a dog all this day."—*Journal*, October 23, 1711. "This morning I felt a little twitch of giddiness, which has disordered and weakened me with its ugly remains all this day."—*Journal*, January 25, 1812. Another characteristic of the vertigo, noted in a quotation already given, is that at one time any slight movement of the head brought it on.

It is certain that this fearful disease, aggravated with the increase of years, had an influence in the causation of Swift's insanity; but that its influence was direct—that is to say, by the extension of the local disease to the brain—is by no means so sure as its indirect effect as one source of the profound depression which marked the latter years of his sane life. We have no authentic account of the first outbreak of insanity, and Sir Walter's statement that, after his understanding failed, "his first state was that of violent and furious lunacy," would seem to have been applicable only to that later period when he suffered indescribable torture from some unknown local disease, producing exophthalmos of the left eye. It is clear there was emotional depression amounting to melancholia, and "much water in the brain," which was probably sub-arachnoid effusion, is sufficient evidence of dementia. But there was also that form of aphasia in which scraps of reasonable language come automatically, though intentional effort can produce no words, and very curiously, in connection with this fact, comes the evidence of the plaster-cast, "brought to light a hundred years after death," that there was right-sided hemiplegia. The knowledge of the importance of this fact also has been acquired since Sir William Wilde wrote his work, and it is not, therefore, surprising that while he so carefully and skillfully marshals the data upon which our diagnosis is now made, he does not connect the right-sided hemiplegia with the very peculiar affection of speech recorded by one of the two authentic witnesses above quoted. Sir William Wilde expresses the opinion that the hemiplegia had existed for several years before death, "for we find the same appearance much glossed over by the artist, together with a greater fullness or plumpness of the right

cheek shown in a very admirable bust, probably the last ever taken." But as Wilde admits, the "six well-known busts of Swift, undoubtedly taken about the same time, exhibit six different forms of head bearing but little resemblance to each other," the much-glossed-over appearance can, therefore, scarcely be admitted as evidence. Probably the stroke of palsy recorded in the plaster-cast had taken place unobserved at or about the time of the actual outbreak of the mental disorder, which might have masked the physical symptoms from observation.

When "the Vandal desecration of monuments" in 1835 exposed Swift's skull to the phrenologists, the great Dublin aurist might possibly have found in the bones of the ear traces of the cause of his giddiness. When Mr. Whiteway examined the brain he might have found the cause of Swift's right-sided hemiplegia and his aphasia. It is enough now that we can diagnose his life-long disease as labyrinthine vertigo, and his insanity as dementia with aphasia ; the dementia arising from general decay of the brain from age and disease, the paralysis and aphasia from disease of one particular part of the brain.

With all the tortures of the life-long disease from which he suffered and its obvious effect upon his temper in his later years, it is wonderful that Swift did retain his reason until, in the seventy-fourth year of his age, he was in all probability struck down by a new disease in the form of a localized left-side apoplexy or cerebral softening, which determined the symptoms of his insanity.

That Swift's works contain no indications of insanity appears to me certain. As well say that Shakespeare was mad because he wrote a good deal which we think nasty. In the fashion of the day, Swift was too prone to make what may be called excrementitious jokes and gibes. But that perfect gentleman Antonio voided his rheum upon Shylock's beard ; and the same kind of thing runs through our literature, no one objecting, until we rather recently began to become less natural and more nice. Some of our smaller humorists and men of letters have criticised this great king of humor as if he were both bad and mad, not perceiving that if he were really insane he must be pitied and not cursed. But it is the weakest of arguments to say, with Festus, for want of argument, "Much learning doth make thee mad." There is always weakness in madness, but there is little sign of this in Swift's works. There is always some inconsequentness or incoherency in madness, but there is none of this in Swift. Down to that last letter to Mrs. Whiteway he is most wretched, but he is still collected and wholly himself.

One final consideration is that the oppressive and disabling nature of Swift's life-long disease has been greatly underrated in the more severe of the criticisms which have been made with regard to his conduct to Esther Johnstone. I do not know that labyrinthine vertigo would necessarily incapacitate a man for the performance of marital

duties, but it certainly might be a barrier to them more formidable than unprofessional critics are likely to suppose possible. Dr. Beddoes suggested that Swift was impotent from youthful dissipation, of which there is not a tittle of evidence. May not the great and grave disease of which I have adduced such copious evidence have been the real reason why Swift did not live with the woman whom it is certain that he loved with the most tender and persistent devotion?—*Brain.*

HYACINTH-BULBS.

By Professor GRANT ALLEN.

IF we were not so familiar with the fact, we would think there were few queerer things in nature than the mode of growth followed by this sprouting hyacinth-bulb on my mantel-piece here. It is simply stuck in a glass stand filled with water, and there, with little aid from light or sunshine, it goes through its whole development like a piece of organic clock-work, as it is, running down slowly in its own appointed course. For a bulb does not grow as an ordinary plant grows, solely by means of carbon derived from the air under the influence of sunlight. What we call its growth we ought rather to call its unfolding. It contains within itself everything that is necessary for its own vital processes. Even if I were to cover it up entirely, or put it in a warm, dark room, it would sprout and unfold itself in exactly the same way as it does here in the diffused light of my study. The leaves, it is true, would be blanched and almost colorless, but the flowers would be just as brilliantly blue as these which are now scenting the whole room with their delicious fragrance. The question is, then, how can the hyacinth thus live and grow without the apparent aid of sunlight, on which all vegetation is ultimately based?

Of course, an ordinary plant, as everybody knows, derives all its energy or motive-power from the sun. The green leaf is the organ upon which the rays act. In its cells the waves of light propagated from the sun fall upon the carbonic acid which the leaves drink in from the air, and, by their disintegrating power, liberate the oxygen while setting free the carbon, to form the fuel and food-stuff of the plant. Side by side with this operation the plant performs another, by building up the carbon thus obtained into new combinations with the hydrogen obtained from its watery sap. From these two elements the chief constituents of the vegetable tissues are made up. Now, the fact that they have been freed from the oxygen with which they are generally combined gives them energy, as the physicists call it, and, when they recombine with oxygen, this energy is again given out as heat, or motion. In burning a piece of wood or a lump of coal, we

are simply causing the oxygen to recombine with these energetic vegetable substances, and the result is, that we get once more the carbonic acid and water with which we started. But we all know that such burning yields not only heat, but also visible motion. This motion is clearly seen even in the draught of an ordinary chimney, and may be much more distinctly recognized in such a machine as the steam-engine.

At first sight, all this seems to have very little connection with hyacinth-bulbs. Yet, if we look a little deeper into the question, we shall see that a bulb and an engine have really a great many points in common. Let us glance first at a somewhat simpler case, that of a seed, such as a pea or a grain of wheat. Here we have a little sack of starches and albumen laid up as nutriment for a sprouting plantlet. These rich food-stuffs were elaborated in the leaves of the parent pea, or in the tall haulms of the growing corn. They were carried by the sap into the ripening fruit, and there, through one of those bits of vital mechanism which we do not yet completely understand, they were selected and laid by in the young seed. When the pea or the grain of wheat begins to germinate, under the influence of warmth and moisture, a very slow combustion really takes place. Oxygen from the air combines gradually with the food-stuffs or fuels—call them which you will—contained in the seed. Thus heat is evolved, which in some cases can be easily measured with a thermometer, and felt by the naked hand—as, for example, in the malting of barley. At the same time motion is produced ; and this motion, taking place in certain regular directions, results in what we call the growth of a young plant. In different seeds this growth takes different forms, but in all alike the central mechanical principle is the same : certain cells are raised visibly above the surface of the earth, and the motive power which so raised them is the energy set free by the combination of oxygen with their starches and albumens. Of course, here, too, carbonic acid and water are the final products of the slow combustion. The whole process is closely akin to the hatching of an egg into a living chicken. But, as soon as the young plant has used up all the material laid by for it by its mother, it is compelled to feed itself just as much as the chicken when it emerges from the shell. The plant does this by unfolding its leaves to the sunlight, and so begins to assimilate fresh compounds of hydrogen and carbon on its own account.

Now, it makes a great deal of difference to a sprouting seed whether it is well or ill provided with such stored-up food-stuffs. Some very small seeds have hardly any provisions to go on upon ; and the seedlings of these, of course, must wither up and die if they do not catch the sunlight as soon as they have first unfolded their tiny leaflets ; but other wiser plants have learned by experience to lay by plenty of starches, oils, or other useful materials in their seeds ; and, wherever such a tendency has once faintly appeared, it has given such an advan-

tage to the species where it occurred that it has been increased and developed from generation to generation through natural selection. Now, what such plants do for their offspring, the hyacinth and many others like it do for themselves. The lily family, at least in the temperate regions, seldom grows into a tree-like form ; but many of them have acquired a habit which enables them to live on almost as well as trees from season to season, though their leaves die down completely with each recurring winter. If you cut open a hyacinth-bulb, or, what is simpler to experiment upon, an onion, you will find that it consists of several short abortive leaves, or thick fleshy scales. In these subterranean leaves the plant stores up the food-stuffs elaborated by its green portions during the summer ; and there they lie the whole winter through, ready to send up a flowering stem early in the succeeding spring. The material in the old bulb is used in thus producing leaves and blossoms at the beginning of the second or third season ; but fresh bulbs grow out anew from its side, and in these the plant once more stores up fresh material for the succeeding year's growth.

The hyacinths which we keep in glasses on our mantel-pieces represent such a reserve of three or four years' accumulation. They have purposely been prevented from flowering, in order to make them produce finer trusses of bloom when they are at length permitted to follow their own free-will. Thus the bulb contains material enough to send up leaves and blossoms from its own resources ; and it will do so even if grown entirely in the dark. In that case the leaves will be pale yellow or faintly greenish, because the true green pigment, which is the active agent of digestion, can only be produced under the influence of light ; whereas, the flowers will retain their proper color, because their pigment is always due to oxidation alone, and is but little dependent upon the rays of sunshine. Even if grown in an ordinary room, away from the window, the leaves seldom assume their proper deep tone of full green ; they are mainly dependent on the food-stuffs laid by in the bulb, and do but little active work on their own account. After the hyacinth has flowered, the bulb is reduced to an empty and flaccid mass of watery brown scales.

Among all the lily kind, such devices for storing up useful material, either in bulbs or in the very similar organs known as corms, are extremely common. As a consequence, many of them produce unusually large and showy flowers. Even among our native English lilies we can boast of such beautiful blossoms as the fritillary, the wild hyacinth, the meadow-saffron, and the two pretty squills ; while in our gardens the tiger-lilies, tulips, tuberoses, and many others belong to the same handsome bulbous group. Closely-allied families give us the bulb-bearing narcissus, daffodil, snow-drop, amaryllis, and Guernsey lily ; the crocus, gladiolus, iris, and corn-flag ; while the neighboring tribe of orchids, most of which have tubers, probably produce more

ornamental flowers than any other family of plants in the whole world. Among a widely-different group we get other herbs which lay by rich stores of starch, or similar nutritious substances, in thickened underground branches, known as tubers ; such, for example, are the potato and the Jerusalem artichoke. Sometimes the root itself is the storehouse for the accumulated food-stuffs, as in the dahlia, the carrot, the radish, and the turnip. In all these cases, the plant obviously derives benefit from the habit which it has acquired of hiding away its reserve fund beneath the ground, where it is much less likely to be discovered and eaten by its animal foes. For it is obvious that these special reservoirs of energetic material, which the plant intends as food for its own flower or for its future offspring, are exactly those parts which animals will be likely unfairly to appropriate to their personal use. What feeds a plant will feed a squirrel, a mouse, a pig, or a man, just as well. Each requires just the same free elements, whose combination with oxygen may yield it heat and movement. Thus it happens that the parts of plants which we human beings mainly use as food-stuffs are just the organs where starch has been laid by for the plant's own domestic economy—seeds, as in the pea, bean, wheat, maize, barley, rice, or millet ; tubers, as in the potato and Jerusalem artichoke ; corns, as in the yam or tare ; and roots, as in arrow-root, turnip, parsnip and carrot. In all these, and in many other cases, the habit first set up by Nature has been sedulously encouraged and increased by man's deliberate selection. What man thus consciously effects in a few generations, the survival of the fittest has unconsciously effected through many long previous ages of native development.—*Knowledge.*

THE JAVANESE CALENDAR.*

By J. A. C. OUDEMANS.

THE Egyptians, Greeks, and Romans regulated their most important field-labors, the sowing and gathering of their crops, etc., by their observations of the movements of the heavenly bodies, as the rising and setting of the stars. It is obvious that this system gives only an approximation to the true time ; for not only the time of the rising and setting of the stars, but also the relative situation of the stars to each other, is changed by the precession of the equinoxes. Notwithstanding this, this system is still used by some of the less civilized peoples of the East Indies ; and, although the Dutch Government employs the Gregorian calendar exclusively in its colonies, the Javan-

* J. A. C. Oudemans, Mededeeling betreffende de sterrebeelden, wier hoogte boven den Horizen, op een bepaald oogenblick van den nacht, door de Javanen ten behoewe van de lanbouw geraadpleegd wordt. Amsterdam, 1881.

ese agriculturist goes to this day by his own calendar, which is based upon the position of Orion and the Pleiades, and the length of the shadow at noon. The geographical situation of Java is such (mean latitude 7° south), that the sun stands at 30½° north of the zenith on the 21st of June, and at 16½° south of it on the 21st of December. The shadow, on the 21st of June, falling in a southerly direction, is nearly double the length of the shadow on the 31st of December, which falls in a northerly direction. The shadow requires six months to pass from its greatest length toward the south to its greatest length toward the north, and a year to return to the same position.

If the length of the shadow on the 21st of June is divided into four equal parts, and the length on the 21st of December into two equal parts, we shall have six equal measures of length corresponding with six unequal intervals of time ; these intervals may then be distinguished according to the length of the shadow. The Javanese avail themselves of this peculiarity of shadows in their country to adjust the division of their solar year, the first day of which corresponds with the 21st of June of the Gregorian reckoning. They divide the year into twelve unequal months (*mangsa*), which are respectively 41, 23, 24, 25, 27, 43, 43, 26, 25, 24, 23, and 24 days long. Independently of this division, the farmer plants his rice and other crops according to the height of Orion and the Pleiades above the horizon. This height is taken either at night-fall, half an hour after sunset, or in the morning, half an hour before sunrise. The following are the names of the calendar months, and the most important observations and farmers' rules that are connected with them :

First month (*Kasa*), forty-one days, from the 21st of June to the 31st of July inclusive. Orion and the Pleiades are visible in the east, respectively 25° and 45° above the horizon. The sun turns back toward the south ; a man's shadow at noon reaches four feet south. The fresh-water fish *iwak bettik* has one spot on its head. It is time to plant the second crop of rice.

Second month (*Kara*), twenty-three days long, from the 1st to the 23d of August. The Pleiades are in the zenith, Orion 70° above the eastern horizon. The *iwak bettik* has two spots. The sun goes farther toward the south. A man's shadow at noon measures two feet south.

Third month (*Ketiga*), twenty-four days, from the 24th of August to the 16th of September. Before sunrise the Pleiades are 70° above the western horizon, Orion in the zenith. The leaves begin to fall from the trees. The *iwak bettik* has three spots. The course of the sun continues to be in the north, and the noonday shadow measures one foot south. The second crop of rice begins to ripen.

Fourth month (*Kapat*), twenty-five days, from the 17th of September to the 11th of October. Before sunrise the Pleiades are 50° and Orion 70° above the western horizon. The *glattiks*, or rice-birds, fall upon the fields in multitudes in search of food. The fruit-trees

have new buds and fresh leaves. The *randoe* fruits are ripe, the cotton appears and begins to fall. The sun rises in the east and casts no shadow at noon. Harvest begins.

Fifth month (*Kelima*), twenty-seven days, from the 12th of October till the 7th of November. The medical plants called *lempoeygang* begin to put out new roots. The swallows called *maog terrik* collect on the slopes of the mountains to feed upon the winged ants that fly out at that time. The chirping birds called *tjekithoets* sing more than usual. The *iwak bettik* has five spots. A man's shadow measures a foot north. Plant maize.

Sixth month (*Kanem*), forty-three days, from the 8th of November till the 20th of December. Heavy rains begin. Plant rice. Orion is visible in the eastern horizon immediately after sunset. Woodcocks appear and resort to the ponds for food. The beetles (*kowangaus*), which were not visible before the rainy season, come down from the mountains to lay their eggs on the green herbage which is half covered with water. The spiders called *kemlandingaus*, which before this time of the year spun their webs horizontally, spin them now vertically. The fruits begin to ripen. The *iwak bettik* has six spots. The sun advances toward the south, and a man's shadow measures two feet north.

Seventh month (*Kepitoe*), forty-three days, from the 21st of December till the 2d of February. Orion and the Pleiades are respectively 25° and 45° above the eastern horizon. Rice-planting is continued. The distillable herb, wood-ivy (*ouvi*), is ripe. The eggs of the beetles open. The *iwak bettik* has seven spots. The sun turns back toward the north, and the shadow measures nearly three feet north.

Eighth month (*Kerraloe*), twenty-six days, from the 3d to the 28th of February. Orion is in the zenith, the Pleiades are 70° above the west. Rice-planting is completed. The *iwak bettik* has eight spots. The *glagahs* begin to bloom. The sun rises in the east.

Ninth month (*Kesauga*), twenty-five days, from the 1st till the 25th of March. Orion is in the zenith at six o'clock in the evening, the Pleiades 70° up in the west. The *iwak bettik* has nine spots. The flowers of the *glagah* fall. The sun crosses the equator.

Tenth month (*Sepoeloch*), twenty-four days, from the 25th of March till the 17th of April. The Pleiades are 45°, Orion 65° up in the west. The spots of the *iwak bettik* have disappeared. The rice is ripe and the harvest begins. The sun is in the north, and the shadow measures from one to two feet south.

Eleventh month (*Destha*), twenty-three days, from the 18th of April till the 10th of May. The rice-harvest everywhere. The nights are cold and the days are the shortest in the year. Orion is visible 16° up in the west at half past six in the evening. The Pleiades are invisible. The *randoe*-trees begin to bloom. The sun goes toward the north and the shadow measures three feet south.

Twelfth month (*Sada*), forty-one days, from the 11th of May till the 20th of June. The Pleiades may be seen at half past five in the morning, a little later Orion. The rice-harvest is finished, cotton and indigo are planted, and the ground is prepared for maize. The shadow measures three feet south, and the sun goes to its northernmost point.

Such, according to our Dutch author, is the calendar of the Javanese. It furnishes a series of careful observations such as we meet only among a primitive people. It also affords numerous examples of the peculiarities not only of the starry skies of the tropics, but also of the meteorological conditions and the properties of tropical vegetation. —*Die Natur.*

SKETCH OF M. LOUIS PASTEUR.

LOUIS PASTEUR, the distinguished French chemist and author of researches in fermentation and the germs of disease which have been fruitful in valuable discoveries, was born at Dôle, in the Jura, December 27, 1822. He entered the university in 1840, became a supernumerary Master of Studies at the College of Besançon, was received as a pupil in the École Normale in 1843, took the degree of Doctor in 1847, and was appointed Professor of Physics in the Faculty of Sciences at Dijon in 1848, and of Chemistry at Strasburg, in 1849. In 1854 he was appointed Dean of the newly created Faculty of Sciences at Lille, and was intrusted with the duty of organizing it. In 1857 he returned to Paris, and became Scientific Director of the École Normale. In December, 1863, he was appointed Professor of Geology, Physics, and Chemistry at the École des Beaux-Arts, and was elected a member of the Institute. He has written numerous works relating to chemistry, and has contributed much to the "Recueil des Savants Étrangers" and the "Annales de Chimie et de Physique"; and for his researches relative to the polarization of light he received, in 1856, the Rumford medal from the Royal Society of London. His work in pure chemistry, however meritorious, and brilliant enough though it was, has been eclipsed by his vastly more important and more fruitful reseaches in fermentation; into the causes of certain diseases of plants, animals, and man; and into the modes of reproduction of the lower organisms (or the theory of spontaneous generation), and the parts which those lower organisms play in the production of chemical changes, and in the origination and spread of disease—in which field he may almost be said to have constituted a new science, and has certainly performed a work of incalculable benefit to mankind. These investigations have been pursued under the light of the theory, to which their results in turn have given additional force, that all fermentations are processes connected with life, and that this life—and any life—is not of spontaneous pro-

duction, but proceeds from some previously existing life or parent. Hence, he has held, and has aimed to show, that fermentation can never take place if all access of germs to a fermentable substance is prevented. From fermentation he has extended his theory of the agency of microscopic organisms in working changes, to the explanation of the origin and multiplication of various infectious diseases, each of which, as well as each kind of fermentation and putrefaction, is caused by its own specific organism.

M. Pasteur took a prominent and most active part in the controversy respecting spontaneous generation, which raged quite bitterly a few years ago. He performed the most decisive experiments that were made, and has contributed more than any other person to turn the current of scientific thought against that theory, and to bring the weight of opinion in favor of his own theory of panspermy. The controversy on this subject, which had been resting for many years after the researches of Siebold, Leuckart, and others, into the mode of development of sexless parasites, was reopened as to the infusoria in 1858 by Pouchet, who affirmed that previous experiments in regard to boiled infusions were inexact, and that boiling did not prevent the appearance of infusorial life, as it would necessarily do if such appearance was dependent on the existence of living organisms or germs in the liquids previous to boiling. M. Pasteur, having become interested in this subject through his studies in fermentation, came forward with his test experiments. The question seemed a very difficult one, and incapable of a definite solution, so that Pasteur's friends, Biot and Dumas, were impelled to counsel him against wasting too much time upon it. They had, however, good reason afterward to revise their opinions. M. Pasteur boiled a suitable organic infusion in glass flasks, which he sealed hermetically while the boiling was going on, so as to exclude the air that might bring in new germs to take the place of those which the boiling had killed. The flasks were then taken to different localities, where, after a time, the necks were broken and air was admitted to the boiled infusion. Pasteur reasoned that if the organisms, which were produced in the liquid on exposure to the atmosphere, were spontaneous growths excited to life by the action of the atmosphere alone, the products would be the same wherever the bottles were broken; but if the manifestation of life depended upon the introduction of new organisms or their germs from the air—since the air of different places would probably contain different organisms and be charged in different proportions with them—there would be different results in different places. The experiments showed manifest differences, in accordance with Pasteur's anticipations, and were considered to demonstrate the existence in the atmosphere of extraneous particles, the introduction of which into an infusion was the necessary condition of life appearing there. Professor Tyndall says of them that they, "carried out with a severity perfectly obvious to the instructed scientific

reader, and accompanied by a logic equally severe, restored the conviction that, even in these lower reaches of the scale of being, life does not appear without the operation of antecedent life. The main position of Pasteur, though often assailed, has never yet been shaken. It has, on the contrary, been strengthened by practical researches of the most momentous kind. He has applied the knowledge won from his inquiries to the preservation of wine and beer, to the manufacture of vinegar, to the staying of the plague which threatened utter destruction to the silk-husbandry of France, and to the examination of other formidable diseases which assail the higher animals, including man. His relation to the improvements which Professor Lister has introduced into surgery is shown by a letter quoted in his 'Études sur la Bière.' Professor Lister there expressly thanks Pasteur for having given him the only principle which could have conducted the antiseptic system to a successful issue."

The most highly appreciated of Pasteur's earlier researches—because they most closely touched the economical interests of his country, and had a direct bearing on the prosperity of one of its great industries—were those which he made upon the disease of the silk-worm. A plague had raged among the silk-worms of France for fifteen years. The revenue from silk-culture had doubled itself during the twenty years before 1853, and appeared at that time likely to continue to increase. Then disaster suddenly fell on the business, and the production of cocoons fell from twenty-six million kilogrammes in 1853, in the course of twelve years, to four million kilogrammes, the fall entailing, in the single year last mentioned, a loss of one hundred million francs, or twenty million dollars. Dumas, the chemist, whose home lay in the district that was most afflicted by the scourge, asked Pasteur, with almost a personal interest in the matter, to undertake the investigation of the malady. Pasteur, says Professor Tyndall, at this time had never seen a silk-worm, and he urged his inexperience in reply to his friend. But Dumas knew too well the qualities needed for such an inquiry to accept Pasteur's reason for declining it. "I put," he said, "an extreme value on seeing your attention fixed on the question that interests my poor country; the misery surpasses all that you can imagine." The disease had been called *pébrine* by M. de Quatrefages, a name which Pasteur adopted; it was outwardly manifested by black spots on the bodies of the caterpillars, and also declared itself in their stunted and unequal growth, the languor of their movements, their fastidiousness toward food, and their premature death. It had already been discovered that the unhealthy worms were afflicted with peculiar corpuscles in enormous numbers, which were also sometimes found in the eggs, and which were connected with the disease. Pasteur directed his attention to these corpuscles, and proved that they might be incipient in the egg, and escape detection, and that they might also be germinal in the worm, and still

baffle the microscope ; but that, as the worm grew, they grew also, and appeared, if they existed, large enough to be detected without difficulty in the moth.

Pasteur's first communication on the facts he had discovered, made to the French Academy of Sciences, in September, 1865, called out some rather sharp criticism on the presumption of the chemist who had ventured to instruct physicians and biologists on a subject that belonged to them. "They found it strange," he says, "that I was so little in the current on the question. They set against me works which had been appearing for a considerable time in Italy, the conclusions of which demonstrated the inutility of my efforts, and the impossibility of arriving at a practical result in the direction in which I was engaged ; and that my ignorance was great on a subject on which studies without number had appeared during the last fifteen years." If the scientific men were thus disposed to reject his new truths, it was hardly to be expected that the cultivators would accept his guidance in a direction contrary to that in which they were going. To strike their imagination, and, if possible, determine their practice, he hit upon the expedient of prophecy. Having inspected fourteen parcels of eggs, and examined the condition of the moths which produced them, in 1866, he wrote out predictions of what would be the fate of the lot in 1867, and placed it as a sealed letter in the hands of the Mayor of St. Hippolyte. When the reports of the cultivators were compared with the forecasts in the letter, in the next year, his prediction was found to have been exactly fulfilled in twelve out of the fourteen cases. Two additional parcels of eggs, pronounced by him healthy, produced an excellent crop.

M. Pasteur's researches in fermentation have been practically applied by him in his process for preserving wines by the application of heat, and his process for manufacturing beer by fermentation sheltered from all contact with air.

In 1874 the Copley medal of the Royal Society was awarded to M. Pasteur "for his researches on fermentation and pébrine." Mr. Spottiswoode, in making the presentation, observed that Professor Pasteur's researches on fermentation consisted essentially of two parts, the first part embracing the examination of the products, and the second the causes of fermentation. Previous observers had noticed the production, in solutions of sugar which had been fermented, of substances other than the two commonly recognized, alcohol and carbonic acid ; but it remained for M. Pasteur to show which were essential and which were occasional products. In regard to the cause of fermentation, "it had been found that certain solutions, when exposed to the air, soon became full of living organisms ; and Pasteur's experiments led him to support the view that these organisms originated from the presence of germs floating in the air. He found that no living organisms were developed if care were taken to destroy all those which might be pres-

ent in the solution, and if the solutions were then carefully sealed up free from air. Nor was it necessary to exclude the air, provided that pure air, free from germs, were admitted. By passing the air through red-hot tubes or through gun-cotton before reaching the solutions, he found that the development of organisms, in such boiled solutions, did not take place. [A single exception was noticed in the case of milk, which required a higher temperature to destroy the organisms.]

Professor Pasteur also examined the gun-cotton through which the air had been passed, and he found, among other things, certain cells to which he attributed the power of causing the growth of organisms in solutions. By sowing some of these cells in solutions which had previously remained clear, and finding that such solutions speedily became turbid from the growth of living organisms, it was proved that the air which had passed through the gun-cotton had lost its property of causing the development of life in solutions, because the germs which the air contained had been stopped by the gun-cotton." The results on this point might be summed up: "1. No organisms are developed in solutions if care be taken to prevent the possibility of the presence of germs; 2. This negative result does not depend upon the exclusion of oxygen; 3. The matter separated from ordinary air is competent to develop organisms in solutions which previously had remained unchanged. Not less important were the results of Pasteur's experiments respecting the chemical functions of the ferment. . . . He proved that those conditions which are most favorable to the healthy growth and development of the yeast-cell are most conducive to the progress of fermentation, and that fermentation is impeded or arrested by those influences which check the growth or destroy the vitality of the cell. . . . To the biologist, two of Pasteur's researches are of very great importance. He has shown that fungi find all the materials needed for their nutrition and growth in water containing an ammonia salt and certain mineral constituents, and devoid of any nitrogenized organic matter; and he has proved that all the phenomena presented by the destructive silk-worm epidemic, the pébrine (even the singular fact that it is hereditarily transmitted through the female and not through the male), are to be explained by the presence of a parasitic organism in the diseased caterpillars."

M. Pasteur's later researches have been continued in the same direction as those which we have already mentioned, and have resulted in a great expansion of the germ theory and its application to useful purposes. Those which have so far been most fruitful in practical consequences are the investigations which he has made into the cause of the cholera in fowls and of carbuncular diseases in cattle and sheep, and into the means of preventing them by the cultivation of the infectious germs in diluting fluids and inoculation with them—investigations the results of which have already been heralded over the whole earth, and the inestimable value and importance of which have

been almost universally recognized. The processes by which he has arrived at his discoveries and the success which has attended his application of them are best told in his own language, and are thus told in his address before the recent International Medical Congress, which is published in the present number of "The Popular Science Monthly." This address, the "Westminster Review" says, "was as fascinating in the unerring sequency of experiments as in the unbounded prospects of preventive medicine foreshadowed, and the masterly unraveling of some of Nature's most occult secrets."

M. Pasteur in 1880 proposed the application of the method which he used in seeking the cause of the silk-worm disease, to the detection of a parasite destructive to the phylloxera, and its cultivation as an antidote to that pest of the grape-vine. He said in a "programme for researches," which he communicated to the Academy of Sciences, on this subject, suggesting an inversion of the problem studied in the case of the silk-worm: "Let us seek a parasite for the phylloxera species, and, far from combating it, let us cause it to multiply and fasten upon the phylloxera till it destroys it, as the pébrine parasitic corpuscle so easily destroyed the silk-worms. . . . The rapid multiplication of the phylloxera is only a trifle beside the vital and propagative power of certain parasites. . . . The hall of the Academy of Sciences is very large; it has a capacity of hundreds of cubic metres. I am sure I could fill it with a liquid of such a nature that, on planting in it a parasitic microscopic organism of the fowl, the whole immense mass would, in the course of a few hours, be troubled by the presence of the organism in such abundance that all the phylloxeras in the world would be, in number, only as a drop of water to the sea compared with the numbers of the parasite of which I speak."

Notwithstanding this, he is so confident of the efficiency of the methods of treatment which his researches indicate, that he has been able to say, in his work on the silk-worm disease, that "it is in the power of man to make parasitic maladies disappear from the surface of the globe, if, as is my conviction, the doctrine of spontaneous generations is a chimera."

Another field of investigation, in which M. Pasteur has made a few preliminary steps, is that of the transmission of human diseases by microscopic organisms. He has now numerous co-laborers in these fields, in England, France, Germany, and other nations, many of whom have become famous through their researches, and who are extending the range of investigation every day; but he was the first to direct attention to this branch, and is still the leader of the company.

M. H. Bouley, speaking in the name of the Academy of Sciences, before the annual meeting of the "Five Academies," said, in special reference to M. Pasteur's work: "See how, at once, Nature has suffered one of her most impenetrable secrets to be snatched from her—the mystery of contagions is unveiled; and Science, enlightened by the knowl-

edge of their cause, is resolving that marvelous problem of transforming the agent that causes death into an agent preservative against its assaults ! . . . Justice," he continued, "is often tardy for inventors ; its pace is frequently so halting that their life is not long enough for them to have time to see it come. M. Pasteur, whom I name at last, has had the privilege of seeing it hasten its pace for him. He is also one of those whose virtue does not rest when it has made their opinion good. Master of what he knew to be the truth, he has desired and has known how to give it force by the evident clearness of his experimental demonstrations, and to force the majority of those who were at first refractory to confess it with him." A writer in the "Westminster Review" gives eloquent utterance to a similar sentiment, when he speaks of M. Pasteur as one "whose researches have yielded so much material profit that one thinks of him as of the orange-tree standing in all the glory of blossom and fruit at the same time."

M. Pasteur was received with enthusiastic acclamations by the International Medical Congress when he arose to make the address which we publish ; and the address was distributed by the Government through all parts of the United Kingdom. The "Graphic," publishing his portrait, published also a remark of Sir James Paget, that, by his discoveries relative to carbuncular diseases he had done for cattle what Jenner had done for the human race. And Professor Huxley has said that he considered the discoveries so important that they were worth all the five milliards of francs which France paid to Germany after the war of 1870–'71.

In 1868 M. Pasteur was awarded a prize of 10,000 florins by the Agricultural Minister of Austria for the discovery of the best means of contending with the silk-worm disease. A decree was signed by Napoleon III and M. Ollivier in July, 1870, but never promulgated, making him Senator. The French Government granted him, in 1874, a pension of 12,000 francs, "in consideration of his services to science and industry," and in the next year increased the pension by the addition of 6,000 francs. The *Société d'Encouragement*, in 1873, awarded him a prize of 12,000 francs for his studies relative to the silk-worm, wine, vinegar, and beer, collectively.

M. Pasteur was elected a member of the French Academy of Sciences in 1862, to take the place of Senarmont in the section of Mineralogy. In 1869 he was elected one of the fifty foreign members of the Royal Society of London. His principal works, besides his communications to the "Recueils des Savants Étrangers" and the "Annales de Chimie et de Physique," are : "Nouvel Exemple de Fermentation déterminé par des Animalcules infusoires pouvant vivre sans Oxygène libre" (Paris, 1863) ; "Études sur le Vin, ses Maladies, etc." (1866) ; "Étude sur le Vinaigre, etc." (1868) ; "Études sur les Vers à Soie" (2 vols., 1870) ; "Quelques Réflexions sur la Science en France" (1871) ; and "Études sur la Bière."

ENTERTAINING VARIETIES.

THE MOUNTAINS OF THE MOON;*

OR,

TRAVELS AND ADVENTURES OF HAKIM BEN SHEYTAN.

TRANSLATED BY F. L. O.

CHAPTER II.

THE grace of Allah be with all who walk in his ways, and with all those who read my words and ponder in their hearts the wonders by him to me revealed! And the peace.

There is a mountain in Monghistan which forms the boundary between the hunting-grounds and the cultivated lands, and, two hours after we had left the rock-tombs, we passed the last brook at the foot of that mountain and entered an open hill-country, with a few inclosed fields here and there, but without a drop of drinking-water. The sun went down before we had reached a human habitation, and, as the sky was almost cloudless, we decided to camp under a hedge of mulberry-trees, whose boughs would shelter us from the night-dew. There was no house in sight, but, walking along the hedge in hopes of assuaging my thirst with a few berries, I saw a light that seemed to flicker in a grove on the opposite bank of a ravine. The Karman had seen it, too, for I saw him climb down the rocks with our water-skin under his arm. But he soon returned. "It was no house," said he. "It was the camp-fire of a traveler, a vagrant, who had made his bivouac in that grove."

"Is he a Monakee?" I asked.

"Yes, sir," said my guide. "You can smell him without crossing this ravine. He is burning pest-weed,† to befuddle himself, after the vile fashion of these people."

I instantly put on my sandals and clambered down the cliffs. The presage had been fulfilled. I had dreamed that I should see the first Monakee in the night. The grove consisted of a copse of tamarinds, with an undergrowth of thorn-trees; and I had already made my way to the upper line of bushes, when I stopped and stood spell-bound at the sight that met my eyes. The fire rose from a pile of brush-wood, under a large tamarind, on the top of the hillock, and at the foot of the tree sat a creature with the form of a human being, but with the face of a hog-baboon.‡ His eyes were small and furtive, his beard a mere fringe of bristles, and his nose, which was bluish-red, had the shape of a cucumber.# He wore neither a turban nor a sword-belt,

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† Yerba-pesta, pest-plant, or stink-weed.

‡ Schweins-Pavian, the *Papio Anubis*.

"En forma de un pepino."

but his shoulders were covered with a mantle of hairy or bristly leather, and his feet with a sort of leathern boxes, apparently of considerable weight. The vessels and implements of his camp were equally curious. He was roasting a fowl by means of a fork-spit, and at his side lay a large goat-skin that seemed to contain a combustible fluid, for whenever he placed it to his lips a rill of drops trickled down his face into the fire, where it flared up like camphor-powder.* But the strangest thing was a small iron pot, at the foot of the tree. It was stuffed with smoldering weeds, emitting a sort of yellowish smoke, and this vapor—which almost overpowered me with nausea—he seemed to inhale with a peculiar relish, for every now and then he would bend his head over the pot and utter a complacent grunt as the reek entered his nostrils. I do not think that he suspected my presence, though his eyes peered around furtively ; but he appeared to be uneasy for some reason or other, and, as he listened to the rustling of the night-wind, he had a curious way of inclining his head sidewise, after the manner of a wary hog. I had watched him nearly half an hour, when I heard behind me the cracking of a dry twig, and, at the same time, the baboon-man suddenly snatched his fowl from the spit and hid it behind the tree. I, too, now heard the sound of approaching footsteps, and, turning round, I recognized the Karman, who had become uneasy at my long absence, and seemed surprised to find me here behind the trees. The man-ape had not seen us yet, for he glared about in every direction ; but, when we stepped from behind the bushes, he rose to his feet—a fat, stout fellow, more than five feet to the top of his unturbaned head—and, in an almost human voice, uttered something that sounded like a question, though I did not understand him.

"What does he say?" I asked the Karman ; but I had hardly spoken those words when the baboon-man again lifted his voice, and—who shall describe my astonishment to hear that brute address me in fluent speech, in the language of the Khundi-Arabs ! "Have pity on me, Aboo-Kunts," said he, joining his hands in a deprecatory way ; "do not drive me from this grove. I am a virtuous pauper, performing a pilgrimage for the benefit of my soul, and hope to meet friends at Beth-Raka."

"Peace be with thee, brother," I replied, as one would answer the appeal of a human being. "Salem Kehamad ! We, too, are strangers and travelers. Eat thy meal in peace ; but, if thou canst spare a cup of drinking-water, I beseech thee to exchange it for our abundant thanks, for we are famished with thirst."

He glared at us in silence. "Strangers ? Then Yesha is merciful," said he, at last, and resumed his seat at the fire. I thought he had not understood me, and asked the Karman to repeat my question.

"Water ! What water ?" said he, looking up with an expression of great surprise. "Yesha Ben Allah ! Are you blind, O brother of

* Yed-el-Káfoor, camphor-dust, a sort of fumigating powder.

my father? Have I four legs, that I should drink water like a beast? My name is Ben Khelpus, and the poorest of my tribe have never drunk anything weaker than brand-acid.* Yet the All-Knowing is the most compassionate. Come here," he muttered, and conducted us to the head of a ravine on the other side of the hill. "There is a kraal at the foot of this gully," said he, "and you will find the good-man in a rock-cell, in the side of the hill, where you see that tall tree, down there."

I thanked him for his kindness, and, as the smoke of his weeds had almost suffocated me, I took this opportunity to bid him a good-night. Since he was going to Beth-Raka, I expected to have his company the next day.

"But do not tell them where you have seen me," he called after us, as we were walking away. "Allah may have hardened their hearts, and I want to eat my supper in peace."

The moon was risen, and we had no difficulty in finding our way to the foot of the hill, and, by groping about the rocks near the tall tree, we discovered what we supposed to be the door of the grotto-house. The occupants, however, seemed to be deaf or fast asleep; we knocked and knocked, but nobody answered.

"Listen, sir," said the guide. "Do you not hear something?"

I put my ear to the door and heard, now plainly, a moaning and groaning sound, that seemed to come from the interior of the cave.

"They are sick, and perhaps in need of help," I whispered. "Shall we open the door?"

I listened again, and once more I distinguished the same sound. It resembled the groan of a dying man, and I hesitated no longer. Forcing my cutlass into the crack of the door, I put my shoulder to the wooden lock, and, at the second wrench, the board yielded with a grating sound. By good luck I had braced my knee against the edge of the rock, and could steady myself by a swift grip, or I should certainly have fallen senseless to the ground, for the effluvium of the cave completely stunned me for a second or two.

"For Allah's sake, what is this?" I cried, as I staggered backward, and, like an answer to my words, I heard an uproar of sudden howls, and a hoarse shout that sounded like the voice of an old man. "Woe! woe!" he bellowed. "Cover your heads—cover your heads! The door is open! Who has done that?"

"Here, my father; friends and men of peace!" I cried, for I thought that they had taken us for robbers. But again the wailing broke out with renewed violence. "Night-prowlers! Madmen! Where are they?" cried the old man, as he stepped forth with his head muffled up in a cloak or blanket. "Where are they?"

"Here!" said I. "Not robbers, my father, nor are we madmen, but travelers, perishing with thirst and craving a drink of water. Be-

* "Brand-Essig" (W.).—A sort of pyroligneous acid.

lieve me, we do not want to rob you," I repeated, for the clamor still continued.

"Not rob us!" cried the old man. "You have already done us a greater harm! If we had not waked up in time, the night-air would have done us an injury which no medicine could undo!"

"Not so, Aboo Mungha," said I, "we heard you groan as in a sore disease, and some of your children are certainly sick; but, if you will let them sleep in the open air, the benediction* of Nature will help them more than all the balm of Feringistan."

"What words are these? You must be a bold unbeliever!" rejoined the old man; "how can Nature or anything natural be possibly good? Who are you?" and putting his hand to my shoulder he pushed me out into the bright moonlight. But my dress and face soon told him that I was a stranger, and his heart then seemed to relent. "My name is Er-Masood; be welcome if you come in peace," said he, and taking my hand he led me to a deep spring at the foot of the hill. "If the men of your tribe drink water, the Holy Ones have guided you well," said he; "this spring is the best in the valley; cattle, and even deer, resort to it from a great distance." He then offered us the shelter of his rock-den, but, seeing that we preferred the open air, he advised us to cover our heads very carefully, and, bidding us good-night, he retired to his cave.

We had left our wander-sacks under the mulberry-hedge, and, as the distance was only short, the Karman offered to fetch them down, while I gathered an armful of grass for our camping-ground. The adventures of this night, however, were not yet ended, for, looking about among the brambles of the hill-side, I discovered a child, a young Monakee, who had hidden himself behind a leafy bush.

"My little brother! what is he doing here?" I asked, when he instantly covered my mouth with his hand, and implored me not to betray him.

"My head ached so that I thought my soul would leave me," he whispered; "pray, let me get a little fresh air before you drive me back!"

He had made himself a couch with his coat and an armful of leaves. To these I added some of the grass I had gathered, and bade him lie down and keep quiet. "I shall not betray him; may Allah be his helper!" I thought, for, on passing the cave, I had again heard the moans of his unfortunate brethren.

When the Karman returned, the moon was shining from a cloudless sky; in the trees and bushes the cicadas chirped their serenades, and on the slopes of the grassy hill-side we saw a swarm of rabbits chasing each other to and fro. They played and gamboled, enjoying the sweet night-air, while the Monakees lay groaning in their noisome cave.

* Eyn-daljah—literally, "the shining face."

The morning dawned in a streak of spear-shaped clouds,* presaging a warm day, so we commended the child to the care of Allah, and ascended the hill before Er-Masood had opened his den. Our red-nosed friend had left his camp, but, when we reached the main road, we met several Monakees driving their working-steers to the field. They eyed us with surprise, and some of them quickened their steps to keep up with us, thus giving me an opportunity to observe them well. Whatever might be their sins, I soon saw that the hand of Allah weighed heavily upon their race. They wheezed and coughed; their children looked pale-cheeked, and, among the three or four score of adults we met on that day, I did not see half a dozen purely human countenances. Some had fish-eyes, and some pig-noses, and nearly all the old males were disfigured by the bloated appearance of their faces. They all marched on their hind-legs, but their gait was remarkably awkward; they can not walk with dignity, and in the cities, where I afterward saw large assemblies of their people, only the younger boys seemed to have anything like a natural grace of deportment. Whenever the road led up-hill, their knees weakened, and they had to pause, panting for breath, while the small dogs that accompanied them went boldly ahead. Their feet were shod with leather boxes, and, though the morning was rather sultry, most of them were muffled up to their chins in blankets or heavy cloaks. These garments, however, were well woven, and, like their agricultural implements, evinced the skill of their artificers. Their conversation, too (whenever they ceased to discuss their various bodily ailments), seemed to turn upon mechanical topics; in matters pertaining to natural science and the wonders of natural history they are strangely incurious; their country-people have no names for the splendid butterflies of their fields, and few of them can identify a single constellation of the starry firmament.† In these border districts a corrupt dialect of the Khundi-Arabs is the prevailing idiom; farther west the vernacular of ancient Monghistan is more generally spoken, though nearly all their educated men have some knowledge of the Arabic language.

On the next steep hill we had left all the villages behind, when we reached a cross-road where we saw a Monakee standing on all-fours, with his head between his hands, and moving his hind-feet up and down like the stampers of a water-wheel. The Karman turned back to me smiling, but I beckoned him to follow me behind a hedge, where we could watch the strange creature unobserved.

"Do you not know him?" whispered my guide; "it is the traveler, the same man we met in the woods last night: that is the way they say their prayers."

* *Nubes rayadas* (R.).

† "The poorest Bedouins," says Professor W., "are as familiar with practical astronomy as a German *Förster* with the slang and mystery of woodcraft. They have names, and even nicknames, for every constellation and every conspicuous star."

I peeped through the bushes and saw that he was right: it was Ben Khelpus, the man with the goat-skin and pest-pot. His performance had lasted about five minutes, when he stopped and turned his head sidewise, and, following the direction of his gaze, we saw a little girl walking across the fields with a sort of basket in her hand. Ben Khelpus crouched down, drew a short club from his bundle, and, rising suddenly on his hind-legs, he made for the field in a kind of a bear-trot. The girl saw him come and ran away, shrieking, but the pilgrim, too, then broke into a gallop, and chased her through a canebrake, where we lost sight of them. In the next minute, however, we heard a loud scream, and a second later Ben Khelpus reappeared, carrying in his hand the girl's basket, which he flung away after devouring its contents. He then returned to the cross-road, where he took a deep draught from his goat-skin, and finished his devotion by performing a number of hand-springs. While he repacked his bundle we left our hiding-place, and approached him from the other side of the road.

"How fares my brother?" I asked, when he turned his head.

"Well! thanks to Allah, whose perfection be extolled," he replied; "a man feels so much better after prayers!"

"Are you, too, going to Kápeebad?" I inquired, as he prepared to accompany us.

"Nearly," said he, "but after a day's journey beyond Beth-Raka, I shall ascend the mountain of Sidi-Máyas, for the promotion of my spiritual welfare— Hold this bundle a moment," said he, when we passed an inclosed orchard; and, after pushing down some of the upper stones, he succeeded in climbing the wall, and soon returned with a cloutful of apricots.

"Are you not afraid the owner might see you?" I asked.

"Not I," said he; "no heretic would dare to lay his hands upon a pilgrim: they fear the vengeance of my fellow-believers."

"Who are those heretics?" I asked.

"Vile misbelievers," replied he; "they waste all their prayers on the nephew of Allah."

"I told you so," said the Karman, who had repeatedly mentioned that shocking superstition.

"Yes, the Horn-Ghost* will roast them severely," added the pilgrim; "they confine their worship to that nephew, and pay no respect to the rest of the family, nor to the three hundred servants of his household. They even despise the gate-keeper of the heavenly mosque."

"And do you hope to enter that gate?" I asked.

"Yesha is merciful," said he; "I constantly make the sign of the

* *El Cornado*, "Old Horny." The horns of Eblis, are not confined to the cacodæmons of the Semitic religions; in the language of the Siberian Yakoots, Atkinson tells us, the local Beelzebub is called "the Old Horn Man," and the national Jehovah "the Gentleman with the Russian Uniform."

holy triangle, and acquit myself of the prescribed prayers; and, moreover, I am going to worship at the shrine of Sidi-Máyas, where I shall perform the three hand-springs, the three somersaults, and the three holy groans, and thus cleanse my soul from sins past and future for three times three solar years."

We passed several well-cultivated fields, and stopped at a camp of field-laborers, where my guide purchased some manioc-roots for our dinner, and informed our companion that he could supply his wants for a single copper coin.*

"Pilgrims carry neither copper nor silver," said Ben Khelpus, "for Yesha supplies all their wants. No, I have no money," he added; "I wish, though, I had; my dram-skin is nearly empty, and these Caffres † will not fill it for me. I shall have to use my club if Allah does not soften their hearts."

The day was oppressively hot, and the sun had passed the meridian, when we at last reached a brook at the foot of a wooded hill. Here we decided to cook our dinner, and, while my companions gathered a supply of fire-wood, I drove away two hogs that offended us by their smell and their greedy grunts. My guide assured me that the Monakees not only tolerate, but fatten and eat these unclean animals—an assertion which seemed hardly credible till it was confirmed by some very suspicious circumstances.

After chasing the brutes out of sight, I ascended to the top of the hill, which afforded a good lookout over the surrounding country. Nearly all the uplands are covered with plantations of poison-berries, and the valleys with pest-weeds, so that the useful products are almost confined to the fruits of a few orchards and manioc-fields. In the rear of the cliffs several acres of ground were inclosed with curious wire-fences, and at the end of the first field I found an open shed containing two plows of excellent workmanship. No plowman or horses were in sight, but higher up I met an old man carrying a heavy tub with a sort of black mold, which he scattered here and there to fertilize his fields. The weight of the tub seemed to bear heavily upon him, for I saw him stagger under his load and clutch at the trees to support himself.

"This labor, father, has overtaxed your strength," said I, when I met him.

The old man put down his tub and had to pant for breath before he could reply. "Yes, it is very hard," said he; "nor is this the worst part of my work: I have to fetch the mold from my garden and carry it up this steep hill."

"Do you live far from here?" I inquired.

* *Jedeed*, a small coin, the tenth part of an Arabian denar.

† Unbelievers. Caffre, as well as Giaour, is derived from *Gebir*—the Gebers, or Fire-worshipers of Western Persia, who so obstinately resisted the inroads of El Islam, that their name became a synonym of "infidel."

"There is my house," said he, pointing to the valley, "over yonder, where you see that large orchard at the foot of the hill."

"And is the produce of that orchard not sufficient to support you?" I asked him.

"My wants, sir, are but small," said he, "but I have a wife and a daughter who are in need of wakkad* trailing-gowns with double tails, and red-squirrel skins are very expensive."

"Have they, then, no other garments?" I inquired.

"Many, sir," he replied, "but they are gray and single-tailed."

"Father," said I, "I am a physician, and it is my duty to warn you," for I had noticed that he breathed with difficulty, like a person exhausted by a grievous cough. Such labor, I told him, would surely aggravate his disease, and if he hoped to recover he must have more rest and better food.

"Alas! we have sold our milch-cow," said the old man, "and I have to furnish those gowns before the end of this season."

"Then repurchase your cow," I replied, "and let your women wear their usual garments."

He sighed and shook his head. "The women of this country have to follow the customs of Moropolis," said he, "a city of great wealth and refinement. The Moropolitans have ordained that trailing-gowns shall be red and double-tailed, and Monghistan has to obey. All the women would be against me: I might defy them, but I dread the consequences."

By much persuasion I at last encouraged his heart, and agreed to follow him to his home. The orchard was not far from our camping-ground; so I hoped to return before my companions had prepared our meal. The old man conducted me through a flourishing tree-garden, and ushered me into his cottage, where we found two women, both unveiled, but of very decorous deportment. "My name is Mak-el-Frit," said the old man, "and this is Pitha, my wife, and my daughter Pitheka."

They received me with politeness and offered me the hospitality of their table; but, seeing a skewered pig upon their hearth, I asked them to excuse me, adding that I would soon be obliged to rejoin my companions.

"How comes it, my husband," said the *kabira*,† at last, "that your labor has ended so long before sunset?"

"It has ended for ever," said Mak-el-Frit, "I can endure it no more"; and, after explaining the nature of his disease, he told them that he intended to repurchase his milch-cow, and that they must content themselves with gowns of gray-squirrel skin.

At these words the two women started up and glared at each

* Aboo-l-wakkad, literally "father of a great tail," a squirrel. The name is applied both to the gray palm-squirrel and the civet-cat of Northern Africa.

† Kabira, the "head-woman," the mistress of a house.

other with bewildered looks; but, when Mak-el-Frit attempted to state his reasons, they saw that he was in earnest, and Pitheka threw herself sobbing upon a bench, while her mother uttered a piercing shriek, and, after clutching at the empty air, sank to the ground as in a swoon. Seeing her fall, I ran out to get a cup of water, but when I returned the two women had recovered and were sitting like monuments on the floor of the room. "Wakkad-russ, wakkad-russ —gray-squirrel skins," the kabira repeated, with a vacant stare, and in a hollow voice, after which they both shrieked louder and longer than before, while a tame monkey leaped down from the window and joined in the clamor. "Mak-el-Frit, are you bereft of your reason?" asked the kabira, after a pause.

The husband seized the monkey and flung it out of the window, but made no other reply. The kabira then turned to her daughter. "I see how it is," said she; "he wants to drive us forth, to beg our bread in a foreign land, where no one knows that I am the daughter of honorable parents. O my child! O my sugar-eating parrot! we shall taste the bread of affliction; we shall wander homeless till our souls return to the peace of Ghinnistan." Then rising to her feet — "And thou, hard-hearted one, who preferrest a cow to thy wife," said she, "go and tell the neighbors that thou hast driven me forth to seek a grave in a stranger's land; for thou shalt behold my face no more.—Come, my daughter," said she, and strode toward the door, when the old man stopped her, and adjured her for Heaven's sake not to darken his countenance.*

"I will do what I can," said he, "and you shall have that gown before long, but may be it will be single-tailed."

"No, double-tailed, by Allah!" said the kabira, "and if you want me to stay I have to impose a strict condition: Never again insult your wife or your daughter by such propositions. Even the beggar-women of Moropolis would despise a gray-squirrel gown, and the daughter of my father shall not become a by-word in the land of her birth. Heed my words, for my father has friends who will not suffer his daughter to be oppressed, nor will they fail to invoke the severity of the law against cruelty insupportable. Will you promise me those gowns, and shall they be duly double-tailed?"

The old man sighed, but made no reply.

"Will you promise?"

Mak-el-Frit hesitated.

"Come, my daughter," said the kabira, "we must leave this house."

"No, no, I will work, I will work!" cried the old man, and seizing his tub he rushed through the open door. When I left the cottage, I saw him hasten toward the hill at the top of his speed. He was an old man, well stricken with age, and the failure of my plan grieved me.

* "Sein Angesicht schwärzen" (W.)—i. e., disgrace him.

Yet this was to be a day of disappointments, for when I returned to our camp the Karman met me at the foot of the grove and informed me that our dinner had disappeared. He had gone down to the creek to fill our water-bottle, and when he returned our maniocs were gone, as well as the contents of our oil-flask, and six pounds of dates which had been taken from our traveling-bag. "The man who did it must be the father of a wolf," * said he, with a mistrustful look at the pilgrim.

But Ben Khelpus protested his innocence. "It is a perfect mystery to me, O fathers of Khundistan," said he, "though it now occurs to me that it may have been one of those swine we saw at the creek. Swine, O brothers of my father, are gifted with an excessive appetite, especially for maniocs. Dates, likewise, they eat with an exceeding great relish."

The Karman looked at me, pointing to the hilt of his cutlass. I understood him, but I shook my head. Determined to get rid of this man, I yet thought it better to let him depart in peace.

"Is there nothing left?" I asked.

"Only a handful of parched durra † and a piece of goat-cheese," replied the guide.

"Cheese? then let us eat it now," said Ben Khelpus—"right now, before it becomes too dry. For to-morrow is the weekly mourning-day, when all true children of Yesha must abstain from cheese. As the Good Book hath it:

> "'Salvation is to him who observes the prescribed fasts,
> And the foot ‡ is safe which avoids transgression.'

What says my father?"

I made no reply, and not a word was spoken till we heard the sound of approaching footsteps. It was Mak-el-Frit, returning to his garden to refill his tub. His heart was heavy, and he tried to pass by in silence, but the pilgrim stopped him. "O my father," said he, "have you any rakee at your house, or any brand-acid? For, by Allah (whose perfection be extolled!), my goat-skin is nearly empty."

Mak-el-Frit sighed and shook his head, but the pilgrim repeated his question. "Is there no pity in your heart?" he added; "have you forgotten the behest of Yesha?"

Mak-el-Frit passed on, and the pilgrim then stepped behind a tree, took a club from his sack, and, after readjusting his bundle, followed the old man with rapid steps. Before he returned we forded the brook and resumed our journey. The heat of the day had moderated, and we hoped to reach Beth-Raka before night.

About three miles west of the ford we overtook a man whom I had seen at the laborers' camp, and who seemed to have passed us while

* Aboo-l-kalb, *padre de un lobo*, R. † *Sorghum vulgare*, a kind of millet.

‡ "Foundation," in the original. In the second hemistich of this verse *eddêm* (foot) should be substituted for *ed-demneh* (footing, or foundation), for the sake both of the sense and the metre.

we were cooking our dinner. He wore a black cloak with a high collar which somewhat concealed the absence of a beard, for his face resembled that of a sick old woman. He seemed, however, to be a person of considerable information, for he inquired after the state of affairs in Fan-Khundistan, mentioning the name of the sheik and his chief counselor. "Where have you left your companion?"* he asked, after I had answered his first questions.

I understood that he referred to Ben Khelpus, and told him under what circumstances we had parted from that pious pilgrim.

The stranger smiled. "That fellow," said he, "belongs to the sect of the *Tripilates*, so called from the triple hat of their chief imam. You have acted wisely; your appearance is that of a learned stranger, and I marveled to see you in the company of that man."

"You do not belong to his sect, then?" I inquired.

"Yesha forbid!" said he; "there are many kinds of superstitious people in this country, but the Tripilates are the worst. They pay divine honors to countless unworthy servants of Allah, while we confine our worship to his nearest relatives. As for myself, I profess the creed of the *Thumpers*,† who were the first to secede from the community of the Tripilates. Our dervishes derive their authority from the first chief imam, whose sacred slap of approval encouraged his successor to continue the work of the Lord. If you come to Kápeebad you will find that nearly all the respectable people belong to our sect. The superstition of the Tripilates," he added, "prevails only in the southern valleys; theirs is a grossly corrupt form of the Yeshanee faith, while ours is a pure and refined doctrine." He stopped and put his hand to his breast—to attest the superior sanctity of his creed, as I supposed, till I saw that he was rubbing his stomach. "I do not feel well this evening," said he, "I have eaten three pounds of fat hog-flesh, and I fear that it was not properly fried."

My amazement at these words increased when we soon after reached the top of a hill where the ground was thickly covered with chestnuts and beechnuts, which, as the Karman informed me, are despised by the Monakees, and serve only to fatten the animals whose mention has already thrice defiled these pages, and whose flesh, as a means of sustenance, a proper person would hardly prefer to the pangs of actual starvation.

While we rested a few minutes, a swarm of wild pigeons alighted in the trees, and almost in the same moment an arrow whizzed from a thicket of brambles, and one of the birds fell fluttering to the ground. The hunter was a bottle-nosed old man, with a perceptible smell of rakee about him, but the workmanship of his cross-bow once more convinced me that it has pleased Allah to endow these people with a won-

* "Prophet," W. By the omission of a letter and the misplacing of a diacritical point, *nedeem* (boon companion) in the Tunisian edition may have been converted into *nedyeh*, prophet or embassador. † *Tocadores* (R.), Klopfer (W.)—Slappers or Thumpers.

derful degree of mechanical skill. The bow-iron was as thick as my arm, but could be bent by means of an ingenious lever ; the cord was made of a curious kind of vegetable fiber, stout, but twisted as evenly as a lute-string, and retaining that appearance under a tension that would have snapped the strongest sinew. The arrows were altogether unlike ours—unfeathered, short and thick, and terminating in a dagger-like point of hardened steel. With a shower of these darts the Monakees have often repulsed the charge of the best warriors of Darfoor and Khundistan.

We had now reached the ridge of this hill-country ; to the west the view was bounded only by an airy-blue mountain-range ; at a distance of now less than twelve leagues we recognized the hill with the towering mosques of Kápeebad, and at our feet lay the town of Beth-Raka, embowered in trees and shrouded in a cloud of murky smoke. At the next cross-road our companion left us, after giving me the names of several learned friends of his in the city of Kápeebad, for I had not mentioned the object of my journey, and, judging from my questions, he probably took me for one of those traveling scholars * who visit foreign countries for the love of learning.

My guide had never been in Beth-Raka before, as Kápeebad can be reached by a road through the northern highlands, which is preferable in the rainy season ; but the suburbs of the city were already in sight, and, as the sun was still more than an hour high, we were in no danger of losing our way. Our road led now steadily down-hill, and we quickened our pace in order to reach the town before dark, for I was curious to ascertain the cause of the black smoke that rose incessantly from the bottom of the valley.

—— *The Summit of the Earth.*—Adolphus Schlagintweit, the immortal though unpronounceable explorer of Central Asia, calls the highland of Pamir "die Welt-Zinne"—the roof of the world. On the road from the Punjaub to Yarkand four passes have to be crossed that are higher than 17,500 feet, and for a distance of 280 miles the halting-ground is not below the height of Pike's Peak. On the eastern plateau of the Beloor-Dagh there is a shelter-house near a cliff from whose summit the main chain of the Himalayas with all its giant peaks and immeasurable ice-fields is in full view from the highlands of Lassa to the sources of the Indus, while in the west the head-waters of the Oxus and Jaxartes can be traced to the borders of Cabool, where the peaks of the Hindoo-Koosh lift their crests of everlasting snow. In spring the echo of the avalanches resembles the boom of continuous thunder; and in midwinter, when the storm-wind sweeps the table-land, whirling pillars of snow scud along the ridges, and often seem to dance together like specters in their fluttering winding-sheets. Our "Land of the Sky" in the Southern Alleghanies must be a mere piazza compared with that top-roof of the earth.

* The scholars of the Arabs, like those of ancient Greece, were mostly peripatetic philosophers. Tabari, Ibn-Koteiba, and Ibn-Baitar traveled on foot through all the provinces of the Saracenic empire.

CORRESPONDENCE.

ANTEDILUVIAN LONGEVITY.

Messrs. Editors.

A LETTER in your February number, from Mr. C. S. Bryant, propounds a new view respecting the age of antediluvian patriarchs, and expresses a hope that the revisers of the Old Testament will give heed to what he regards as cases of apparent errors in the reading of Hebrew numbers. Being one of those revisers, I may, perhaps, properly ask for a little space in which to comment on his suggestions. While I have no doubt of his sincere desire to solve a serious difficulty, I must say that his theory is utterly untenable. This can be easily shown.

Mr. Bryant says, "In reading *concrete numbers*, the Hebrews gave the larger number first." This is true in some cases, in others not. Thus in Genesis xiv, 14, the Hebrew gives the number of Abram's servants as "eighteen and three hundred," the larger number last. Even in Genesis v, 3, adduced by Mr. Bryant, the Hebrew reads, "thirty and a hundred years"—the larger number last. In like manner also in verse 5, Adam's age is said to have been "nine hundred years and thirty years." I do not see, therefore, the bearing of this inaccurate observation. Mr. Bryant's point really is (though he does not state it) that, though the Hebrew inserts no conjunction "and" between "nine" and "hundred," we may read it "nine *and* a hundred and thirty." When he speaks of an inverted rule in the case of verse 5 (authorized version), and says that verse 3 translated in the same way would read "thirty hundred years," he overlooks the fact that in verse 3 the Hebrew has a conjunction between the two numerals, reading "thirty *and* a hundred," so that the most literal translation would still give us one hundred and thirty. In short, the authorized version renders with perfect exactness.

The real question, then, is whether Mr. Bryant's method of putting in a conjunction where there is none in the Hebrew is justifiable. In the case in question the word "hundred" is in the *plural*, so that, exactly rendered, it would be "nine hundreds year, and thirty year" ("year" being singular, as we often say, colloquially, "a hundred foot"). Mr. Bryant overlooks this fact, which is very inconvenient for his theory. Even, therefore, though we might imagine that "nine hundred and thirty" really should be read "nine, one hundred, and thirty," the plural form "hundreds" is unexplained.

Mr. Bryant says, "At the date of this writing the Hebrews had no means of writing 'nine hundred,' or any number of hundreds above one, without repetition or circumlocution." This is an assertion without proof, and needs no answer. That it borders on the absurd is obvious to almost any one.

But more conclusive proof of the error of Mr. Bryant's hypothesis is yet to come. It prepares any one to expect it when, e. g., Seth's age, according to him, is stated (verse 8) as "twelve years, and nine [and] a hundred years," and so is equal to one hundred and twenty-one! Circumlocution indeed! Could not the poor Hebrews express even 21 better than by adding 12 to 9? So Enos's age is got by adding 5, 9, and 100!

But the absolutely knock-down argument is this: Mr. Bryant says (without telling us how he learned it) that "Seth was born when Adam was one hundred and thirty years old, and was his last child." But he forgets to quote verse 4, which says (according to his own method of translating), "And the days of Adam after he had begotten Seth were eight [and] a hundred years." Thus, adding 130 to 108 we get necessarily 238 as Adam's age at his death. And yet, absolutely overlooking this, Mr. Bryant makes Adam's whole age to have been only 139! Precisely the same absurdity results in the following cases: Seth at the birth of his son was one hundred and five years old. But *after* the birth of Enos he lived (verse 7), according to Mr. Bryant's own way of translating, "seven years, and eight [and] a hundred years." So, then, at his death, Seth must have been 105 + 115 = 220 years old. But Mr. Bryant, translating verse 8 in his peculiar way, makes the age to be one hundred and twenty-one! We have, in the mention of the age before and that after the birth of the son, an absolute test of the correctness of Mr. Bryant's theory as compared with the ordinary one. According to the ordinary one, the two numbers added together make exactly the number given as the whole age. According to Mr. Bryant's theory, the narrator can not add together any of the two numbers correctly. He contradicts himself, so that the merest child can see the blunders.

If Mr. Bryant thinks that this method of reducing the ages of the patriarchs is going to relieve the biblical narrative of difficulty, he is obviously mistaken. I repeat that, he may be very sincere; but, in view of what has been presented, his sincerity can be

vindicated only at the expense of his good sense and intelligence.

Yours truly, C. M. Mead.

Andover, Massachusetts, *January* 31, 1882.

Messrs. Editors.

A note in your department of correspondence, February number, page 553, on "The Duration of Human Life," by Charles S. Bryant, of St. Paul, Minnesota, calls for an answer. I do not undertake or need to reply to it in full. It would be enough to follow the saying, *Ex uno disce omnes.*

Says Mr. Bryant, "Seth was born when Adam was one hundred and thirty years old, *and was his last child.*" He says this which I have italicized, although, in the Scripture account, the very next words to those concerning the birth of Seth (Gen. v, 3) are, "And the days of Adam after he had begotten Seth were eight hundred years, and he begat sons and daughters" (Gen. v, 4).

Here I might drop the matter, simply saying that this is a specimen of Mr. Bryant's statements throughout the letter. But I will follow them a little further. Mr. Bryant does not pretend to question the record that "Adam lived a hundred and thirty years and begat . . . Seth"; but, where the account adds, as quoted above, that "after this he lived eight hundred years," he gives him nine years! Now, even his own so-called "rule" about the Hebrew reading of "concrete" (*sic!*) numbers—*the largest, first*—could not twist eight hundred (800) into nine (9). This "rule" itself applied to eight hundred would give a hundred and eight, which added to one hundred and thirty, would be two hundred and thirty-eight, instead of Mr. Bryant's one hundred and thirty-nine, for Adam's lifetime.

Carry out this process of examination (and any bright school-boy can do it), and Mr. Bryant's amazingly shrunken "table" of the ages of the antediluvian patriarchs at death (page 554) is, according to his own (and I know not whose it is, if it is not his own) "rule," elaborately wrong in *every instance.*

But, now, whence comes this "rule"? The Hebrew grammar (see Conant's "Gesenius," for instance) teaches that "when *units and tens* are written together, the *early* writers commonly place the units first, as 'two and twenty'; the *later* writers almost invariably reversing them, as 'twenty and two.'" But what has this to do with writing hundreds, thousands, etc.? Nothing at all. The "rule" is—mythic—to say the least of it.

Again, that "at the date of this writing, the Hebrews had no means of writing nine hundred or any number of hundreds above one, without repetition or circumlocution," is as untrue as it is to say that we now have no such means. Mā-âh was *one hundred;* mâthăyim (a *dual* form) was *two hundred;* sh'lōth mā-ōth (the last a "construct form" of mā-âh, one hundred) was *three hundred;* and so on throughout. There was just as much "circumlocution" in this as there is in our language, and no more.

The fact is, that in Gen. v, 3, the Hebrew says, "Adam lived thirty *and* a hundred years (sh'lōshïm *u* m'ăth shânâh)," i. e., one hundred *and* thirty years; while in the fourth verse it says, "And all the days of Adam after he had begotten Seth were eight hundred years (sh'mōnĕh mā-ōth shânâh)," with no *and* (*u* or *v*) between eight and a hundred; and no "rule," let us remember, but Mr. Bryant's fictitious one, for putting the "larger" number one hundred before the "smaller" eight. In the fifth verse, in exactly the same unmistakable way, the Hebrew says, "And all the days that Adam lived were" (not "a hundred years and thirty years and nine years," as Mr. Bryant expressly and untruly states it, but) "nine hundred years and thirty years," just that and nothing else.

I am prompted to take the trouble to write this, and ask you to publish it, because the positive and yet positively false and misleading article in hand not only might do, but is doing, violence to truth between the covers of a scientific journal. In the Teachers' Institute of our city, a company numbering some two or three hundred, I had, not long ago, given a summary of general history, when this very article was referred to by a teacher, in remarking upon the exercise as perhaps affording an explanation of, and a way to remove, the "difficulty" (?) in the Bible account of the longevity of the antediluvians. Even though there were any real difficulty here (I am glad to see that M. de Solaville does not feel obliged to get rid of a difficulty at this point, but only mentions some offered explanations of a remarkable fact), the cool fabrications of the letter I criticise are not the means that would remove it.

Albert Bigelow.

Buffalo, New York, *February* 15, 1882.

AN ELECTRICAL NUISANCE.

Messrs. Editors.

The scientists will confer a boon on one of our mechanical trades if they will suggest some practical solution to the following difficulty: Every one conversant with the machinery of the press-room of a large printing establishment has heard of the great annoyance caused by the generation of electricity while the sheets are passing through a cylinder press. The action of the fluid causes the sheets on issuing from the press to adhere closely, and at all angles, to the

"fly" or rack which takes the sheet and inverts it upon the receiving-table. After leaving the fly, the sheets, as they are piled a hundred or two deep, are attracted to each other, so much so that more than ordinary force is necessary to remove one sheet from another. The pile of printed matter, as placed by the fly on the receiving-table, should be evenly and neatly placed, but because of this difficulty it is left at all sorts of angles. The result is, that not more than one half the work can be accomplished that might otherwise be done. My own observation of the matter leads me to the following conclusions: 1. That the electricity is generated by some paper in greater force than by others, sized and calendered book-paper proving the most troublesome. 2. That the paper, if wet, causes an instant solution of the trouble. 3. That experiments tried, such as connecting the wooden fly with gas or water mains, by means of a good conductor, covering the receiving-table with a metal surface and wiring this to conductors, or connecting different parts of the press when in motion by wire connections, with the hope of neutralizing the positive and negative currents, have all failed, and in the language of the foreman of one of our largest printing establishments, "We must keep our temper, and endure the annoyance till science comes to our aid," by a practical solution of the problem, we mean a solution subject to the following conditions: We can't afford to hire a boy to make adjustments for the escape of the nuisance. We can't *wet* a book paper without ruining it. We can't have the "fly" of *iron* rather than of wood, as that would make it too heavy. With these conditions, can you, Mr. Editor, give us help, and do the printers a service?

A. W. Bacheler.

Manchester, New Hampshire, *Feb.* 20, 1882.

EDITOR'S TABLE.

GOLDWIN SMITH ON SCIENTIFIC MORALITY.

AMONG all subjects now undergoing investigation there is, perhaps, none so important as that of the relation of science to morality; and hence every real contribution to it, however apparently slight, should be cordially welcomed. But it is not the easiest of subjects to deal with. The number of those qualified for the original elucidation of scientific ethics is not great; traditional opinions resist revision, and there is a wide-spread jealousy of science which resents its entrance into this sphere of thought as a needless and a dangerous intrusion. This often gives rise to a one-sidedness and an unfairness in controversy that are greatly to be regretted. The argument of Professor Goldwin Smith, which we republish, notwithstanding the ability with which it is written, is open to this objection. We give it in full as a first-rate representation of the "other side" (which we have been accused of neglecting), but it can not be suffered to pass without some emphatic protest.

In the first place, there seems a misleading element in Professor Smith's question-title. It would naturally be inferred that the paper is an inquiry into the validity and adequacy of a code of morals scientifically based; but this is not so. The writer does not ask, "Is science competent to elucidate the grounds and determine the principles of morality?" nor, "Is there such a thing as a valid science of ethics?" nor, even, "What is the relation of science to morality?" but he asks, "Has science *yet* found a *new basis* for morality?" The implication here is, that science has been hunting after something of questionable existence, and now claims to have found it, and offers it as a new foundation of morals. This conveys a wholly wrong impression of the nature of ethical science. Professor Smith might as well have asked, "Has science yet found a new basis for combustion?" The answer will, of course, depend upon what is meant by a "new basis"; but any answer only raises the further question, "What has science really done in regard to the phenomena of combustion?" To this we

should have to say that combustion is a natural process of which men knew a great deal that was true and indispensable long before science appeared. What science did was simply to develop, step by step, the pre-existing common knowledge upon the subject into a more complete, accurate, and methodical form. So also with morality, or the phenomena of human conduct, in respect to its quality of right and wrong. Much was known about it that was true, practical, and essential to human society before science was ever dreamed of. But the early knowledge was imperfect, and required to be improved and made more clear and systematic by the establishment of principles, as has been the case with other forms of knowledge that have gradually grown into science. There was never any "new basis" in this process of growth. Practical morality has always been grounded in nature and in common experience—has always, to some extent, recognized the right and wrong of human conduct as determined by the known consequences of human actions. Scientific morality was never something to be "found" or done without; it was an inevitable stage in the development of thought and a part of the great modern movement of the study of the order of nature. The problem has not been to find a new thing to replace an old one, but to make the old one better. The problem of our time has come to be to determine the bearing of the later and more highly developed sciences upon the improvement or progress of ethics.

Professor Smith believes that owing to the great advances of modern thought there is a loosening of old bonds and a great peril to morality. He says: "Science, in combination with historical philosophy and literary criticism, is breaking up religious beliefs; and the break-up of religious beliefs is attended, as experience seems to show, with danger to popular morality." Twenty-five years ago Herbert Spencer foresaw the emergency that Professor Smith declares has now arisen, and, adopting what Professor Smith considers to be the "unspeakably momentous" principle of evolution for his guide, gave himself entirely to the mastering and reconstruction of those divisions of knowledge which lead up to ethical science, or "the establishment of rules of right conduct on a scientific basis." Having reached the subject with this profound and systematic preparation, he has given us a preliminary outline of his views of scientific morality in the small volume of the "Data of Ethics." Professor Smith's article is an attack—and, we regret to say, a most unscrupulous attack—upon this book.

Throughout his article Professor Smith represents Mr. Spencer as asserting, in his ethical volume, that the individual is to decide the right and wrong of an action by a direct balancing of the pleasures and pains involved, not to the community in general, but simply to himself. This is not so. Even had Mr. Spencer made no disavowal of this doctrine, the most cursory examination of his work would have shown that he takes no such position. But, when he dwells specifically upon the point, shows the fallacy of the idea, and explicitly repudiates it, the charge made against him is, to say the least, without excuse.

Spencer says, "It is quite possible to assert that happiness is the ultimate aim of action and at the same time to deny that it can be reached by making it the immediate aim." And, again: "The view for which I contend is, that morality, properly so called, the science of right conduct, has for its object to determine how and why certain modes of conduct are detrimental and certain other modes beneficial. These good and bad results can not be accidental but must be necessary consequences of the constitution of things; and I conceive it to be the business of moral

science to deduce from the laws of life and the conditions of existence what kinds of action necessarily tend to produce happiness, and what kinds to produce unhappiness. Having done this, its deductions are to be recognized as laws of conduct, *and are to be conformed to irrespective of a direct estimation of happiness or misery.*" The italics are our own, but they broadly and positively define Mr. Spencer's position to be the reverse of that charged upon him in this article. Yet, notwithstanding this unequivocal statement, it pleases Professor Smith to represent Spencer's moral doctrines as absolving men from all moral obligation, and as giving a virtual license to crime by making immediate pleasure and pain the test of right and wrong; and, that his accusation might be sufficiently offensive, he draws pictures of a voluptuary and of a murderer excusing their actions by the principles of the "Data of Ethics."

But Professor Smith goes still further, and labors to show that Mr. Spencer has laid down principles which he has not himself the courage to pursue to their applications, and which cut up, root and branch, all pretext of any morality whatever. He quotes largely and repeatedly, from a late book of Dr. Van Buren Denslow, certain brutal passages in which the idea of any morality, except the will of the strongest, is sneered at as ridiculous. It is denied in these quotations that there is any such thing as a moral law which is broken by lying or stealing, and it is declared that the rules which have arisen against these practices are only expressions of a predominant brute force in society, which maintains them as a means of imposing upon and plundering the weak and the defenseless.

And how does Professor Smith make out that this is the outcome of Spencer's doctrines? By representing that Dr. Van Buren Denslow is a "profound admirer" and a "disciple" of Herbert Spencer who is only more "fearless" than his "master," and carries out his doctrines to their legitimate conclusions. The "Saturday Review" reproduces the substance of Professor Smith's article, and gives special distinctness to this feature of it. It says: "The case will become clearer if we turn from Mr. Spencer himself to his American admirer and disciple, Dr. Van Buren Denslow, who, as sometimes happens with disciples, has carried out his master's principles more consistently to their logical results. In a work entitled 'Modern Thinkers,' and commended to the public by a preface of Mr. Robert Ingersoll's, the chief apostle of agnosticism in America, he argues that on scientific principles there is no such thing as a moral law irrespective of the will of the strongest."

Now, the whole force of this case depends upon the assertion of Goldwin Smith that Dr. Van Buren Denslow is a "disciple" of Herbert Spencer. But the assertion is not true in any sense or in any degree. On the contrary, Dr. Denslow is an open antagonist of Mr. Spencer. His essay on Spencer's philosophy, first published in the Chicago "Times," while speaking of the man in the usual terms of perfunctory compliment, as have also Goldwin Smith and the "Saturday Review," is adverse, carping, and depreciatory on every point that he considers. The criticism was regarded as so damaging that Spencer's friends were told they must reply to it or for ever hold their peace; and we were confidently assured that the last we should ever hear of Spencer's system was the thud of the clods that Denslow had thrown upon its coffin. When the revised essay appeared in "Modern Thinkers," there was added a sharp attack upon the "Data of Ethics," in which the whole argument was scouted. And yet this man is paraded as Spencer's "disciple" for the unworthy purpose of fastening upon him the odium of opinions in total contradiction to all that he has ever written.

Mr. Spencer is accused of relaxing the restraints of morality; but he has simply sought to make its reasons clearer, its foundations deeper, and to give to its principles the authority of science. Is morality weakened by being better understood, or are its obligations loosened by changing blind rules into rational principles? It is the peculiarity, and we may add that it is the difficulty, of scientific ethics that it is the most stringent of all systems. Where else are we taught so emphatically that the penalties of misdoing follow necessarily in the very nature of things and can not be escaped? Scientific ethics teaches that moral laws can not be broken with impunity, because of the inexorable causal relation between actions and results. This is, indeed, its great power as a controlling system, and it needs but to be thoroughly realized to exert its full influence. That it can not be so realized is largely because the community is educated in a different system. While it is recognized in common experience that immorality has its natural retributions, and while society embodies this principle in its laws by annexing inexorable penalties to criminal actions, yet the moral system which claims the highest sanction is of quite another order. A morality is taught by religious authority in which sins are forgiven in the sense of a remission of the penalties of immoral actions. In the current moral code the relation of cause and effect in conduct, as an inevitable law, finds no place; nay, the doctrine that the consequences of evil-doing may be escaped is a permanent ground of appeal to the evil-doer.

Professor Smith says: "Can it be maintained that the belief in an All-seeing Eye—in infallible, inflexible, and all-powerful justice, in a sure reward for well-doing and a sure retribution for evil-doing—has been without influence on the conduct of the mass of mankind?" But has the belief in an All-seeing Eye been associated in the past, or is it now associated, with "infallible, inflexible justice"? Are we not rather taught that the All-beholding has a plan by which the "vilest sinner" may be saved from the consequences of immoral conduct? Do our ten thousand churches teach this view, or do they not? In what system is righteousness accounted as but "filthy rags"? Is it agnostics, or theists, who for centuries have trafficked in absolution? Who furnishes the weekly passports of murderers from the gallows to glory? Stupendous and immortal penalties have been threatened against wrong actions, and then the evasion of these penalties has been conveniently provided for. Is not this easy system of morals, which arranges for the defeat of justice, more open to the charge of laxity than a scientific system in which penalties are both proportioned to transgressions and follow them with a salutary certainty?

INDEX TO "THE POPULAR SCIENCE MONTHLY."

THE present number closes the twentieth volume of "The Popular Science Monthly." The contents of these volumes are esteemed so valuable for reference that there have been many applications for a full index. This is now in preparation, and will shortly be issued in a separate form.

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES, No. XXXIX.

THE BRAIN AND ITS FUNCTIONS. By Dr. J. LUYS, Physician to the Hospice de la Salpêtrière. D. Appleton & Co. Pp. 327. Price, $1.50.

WE have here one of those striking cases, unfortunately too rare, in which the very ablest man makes the most thoroughly popular book. Dr. Luys, at the head of the great French Insane Asylum, is also one of the most eminent and successful investigators of cerebral science now living; and he

has given, unquestionably, the clearest and most interesting brief account yet made of the structure and operations of the brain. The books of Drs. Luys and Bastian are to a great degree supplementary to each other. Dr. Luys, in treating "The Brain and its Functions," confines himself to the human brain, and makes his work an exclusively human study. Dr. Bastian, in his "Brain as an Organ of Mind," deals comprehensively with the supreme nerve-centers of the whole animal series. His work is profusely illustrated with diagrams of the figure and anatomical structure of the brains of all grades of animals; while Dr. Luys, passing by the whole scheme of inferior life, has but six illustrations in his book, and these are designed simply to make clear the offices and relations of fundamental parts, so as to explain the corporeal conditions of psychical processes.

We have been fascinated by this volume more than by any other treatise we have yet seen on the machinery of sensibility and thought; and we have been instructed not only by much that is new, but by many sagacious practical hints such as it is well for everybody to understand. Lest we be thought to speak too strongly in commendation of the sterling character of this work, and in order to give some idea of the author's method, we quote the following excellent statement concerning it from the columns of the "St. James Gazette":

No living physiologist is better entitled to speak with authority upon the structure and functions of the brain than Dr. Luys. His studies on the anatomy of the nervous system are acknowledged to be the fullest and most systematic ever undertaken. He begins by treating the soft and delicate material of the brain-tissues with chromic acid, which hardens it so as to fix it sufficiently for the purposes of laboratory work, without altering or distorting its essential constitution. He then cuts off very thin slices of the tissue one after another, and, by employing different chemical reagents for which the various minute elements of the brain have varying susceptibilities, he obtains transparent colored sections of the nervous matter, which throw into strong relief the distinction between cells and fibers, besides exhibiting clearly the nature and direction of their intricate ramifications. In this manner he has systematically made many thousand delicate sections of brains, horizontally, vertically, and laterally, at distances of a millimetre from one another, each of which he photographs, till at last he has succeeded in producing a series of maps of its entire structure which place the relations of its organs in strikingly novel lights. The first division of his present volume is devoted to summing up briefly the main results of these important researches. The late Professor Clifford has already popularized them in part for the English reader; but we believe this is the first time that they have been definitely set forth in any fullness before the general public on this side of the Channel.

Confining his attention to the cerebral hemispheres alone, without entering into any particulars as to the cerebellum and other minor appendages, Dr. Luys begins by pointing out the fundamental distinction between the nerve-cell or real central organ and the nerve-fiber or connecting thread. The first answers to the telegraph-office, the second to the wire uniting one office with another. The gray matter which forms the outer covering of the convolutions consists of closely packed cells, and is thus really the essential brain; the white matter in the center consists of fibers aggregated into bundles, and is thus really a mass of large nerves. Of the single cells themselves, with their numerous converging fibers, as well as of their arrangement in superimposed layers, Dr. Luys gives very graphic and instructive diagrams. The business of the cells individually and of the gray matter as a whole is to receive sensory messages from the external organs of the senses and to transform or to co-ordinate their impulses into the proper movements—as, for example, when we see a fruit or flower, and stretch out our hands to pick it. The white substance is shown to consist of numerous interlacing fibers, having for their function the conveyance of such information from without inward, or the carrying down of such motor impulses from within outward. Their definite arrangement in regular lines between the two hemispheres, as well as between the surface of the convolutions and the optic thalami and corpus striatum, is admirably shown by diagrammatic figures. This is the most important result of all Dr. Luys's work. He has made it clear that sense-impressions traveling from the eyes, ears, or skin, arrive first at the bodies known as the optic thalami; that they are there re-enforced and worked up, as it were, in special ganglia; and that they are thence reflected to the surface of the hemispheres, where they are finally converted into appropriate movements. He has also fairly settled the fact that certain minor bodies within the optic thalami are closely connected with the main nerves of sight, smell, taste, and hearing respectively, and that they must be considered as subordinate or intermediate centers where the data supplied by those senses are put into shape for consideration on the surface of the brain. The normal course of an excitation in the sense-organs seems to be this: it first proceeds along the fibers to its own subordinate center in the thalami; it then passes up to the corresponding portion of the convolutions; it there for the

first time affects consciousness ; and it is finally reflected back to the corpus striatum, whence it goes down the motor fibers to perform whatever actions have been decided upon for it by the conscious cells.

ADOLPH STRECKER'S SHORT TEXT-BOOK OF ORGANIC CHEMISTRY. By Dr. JOHANNES WISLICENUS, Professor of Chemistry in the University of Würzburg. Translated and edited, with Extensive Additions, by W. H. Hodgkinson, Ph. D., and A. J. Greenaway, F. I. C. New York: D. Appleton & Co. Pp. 789. Price, $5.

LET no one suppose that in this "short text-book" we have to deal with a primer. Everything is comparative, and the term "short" here has relation to the enormous development and extent of recent organic chemistry. This solid and comprehensive volume is intended to represent the present condition of the science in its main facts and leading principles, as demanded by the systematic chemical student.

We have here, probably, the best extant text-book of organic chemistry. Not only is it full and comprehensive and remarkably clear and methodical, but it is up to the very latest moment, and it has been, moreover, prepared in a way to secure the greatest excellences in such a treatise. The original "Text-Book of Organic Chemistry," by Adolph Strecker, was a work of great merit, which stood high in Germany, and passed through several editions. The author was vigilant in keeping it up to the time, and was about to enter upon the preparation of the sixth edition, making important changes required by chemical progress, when his labors were cut short by death in 1871. Professor Wislicenus, the accomplished chemist of Würzburg, was then induced after considerable reluctance, owing to the pressure of his official duties, to undertake the task which the author was prevented from accomplishing. This was done in so thorough a manner that, while much of Strecker's best work remained, it received a new cast and a more perfect adaptation, both to the state of the science and to the requirements of those for whom it was primarily intended. So largely was the treatise impressed by the originality of Professor Wislicenus that it became generally recognized as his work; and, when it was proposed to reproduce the book in English, Professor Wislicenus only consented on the condition that the very latest results of research in organic chemistry should be embodied in it. He stipulated that "regard shall be had to the largely increased material and essentially nearer insight into the relations and nature of organic compounds already known, that have been obtained since the publication of the book." Drs. Hodgkinson and Greenaway seem to have faithfully carried out this conscientious purpose of the author.

It is not necessary to attempt here any statement of the method or classification of the book, as it would take more room than we can give, and, after all, would concern chiefly the special students of organic chemistry. The names upon the title-page are the best guarantee of the character of the volume, and an examination of its pages shows that it has been executed with remarkable clearness and accuracy. In regard to the formulæ based upon the atomic theory which now play so prominent a part in organic chemistry, Professor Wislicenus admonishes students that they must be taken with great reserve. On this point he says: "In the present state of our science we can not neglect the frequent use of structural formulæ based on the valency of the chemical elements. Their partial uncertainty and, in many points, tangible short-comings, need not prevent their use to some extent in a text-book, although their use requires care. With regard to the manner of writing the constitutional formulæ, no dogmatic adherence to any single method will be adopted, so that the formula of one and the same substance may be found varyingly written in different places. With every one of these systems of formulæ there is the danger of substituting a concrete image in place of an idea. These images we certainly can not do without, but we must keep the idea lying behind such an image as far as possible pure, and also mobile, seeing that in comparison with older views we have in it only relative not absolute truth."

SENSATION AND PAIN. By CHARLES FAYETTE TAYLOR, M. D. A Lecture delivered before the New York Academy of Sciences, March 21, 1881. New York: G. P. Putnam's Sons. Pp. 77. Price, 75 cents.

THIS interesting monograph is an important practical contribution to what may be called the science of illusions. It is a curi-

ous study in medical psychology, in which the author draws upon an extensive practice for illustrations of the phenomena of self-deception in the processes of sensation and the experience of pain. The first portion of Dr. Taylor's lecture is devoted to a brief account of the action of the nervous system, not only as a receptive apparatus for the production of sensibility, but as a reacting mechanism in which sensations are stored and accumulated to give rise to centrally-initiated feelings and impulses. "Up to a certain point," says Dr. Taylor, "and in a certain degree and manner, we are unquestionably automata. If it were otherwise, life would be simply impossible. The sensations which we receive through the five senses set a-going certain machinery, the result of which is sensory life, as certainly as the open valve lets in the steam which makes the ponderous engine throb with motion and power. But steam, having once been used, flows out lifeless, a simple waste. Not so the sensations. Once received, they are never wholly spent, but in various forms remain as a portion of our vital selves so long as we live. And, once received, we may use and control their accumulated substance much as we will."

But if illusions arise in the action of the peripheral senses, so definite in their action and so open to observation, they are far more liable to arise in regard to the feelings which come from centrally-initiated impulses, and prominent among these deceptions are the false location of pain and the false interpretation of centrally-initiated impressions. On this point Dr. Taylor remarks: "If the direct evidence of our special senses can not be depended on, as previously shown, how much greater must be the liability to error, when conclusions are drawn from feelings depending on those pulses of nerve-force which have been set up in the cerebral end of the nervous system! And yet, large numbers of people take the evidence of their feelings, having nothing but an emotional origin, as evidence of bodily conditions. An emotional temperament is simply one in which the pulse of action in the nerve-centers rises higher than the occasion requires. There is a throb or explosion of energy, under a stimulus which would produce only a pulse in ordinary persons. Æsthetic education, particularly when not accompanied by special discipline, tends to increase inherited habits, until the existence of some persons consists of successions of nerve-center explosions, with all the prodigal waste of energy which accompanies that state. Such a person is thrown into ecstasies of pleasure or pain by causes by which a balanced temperament would not be affected. If a lady, she has a large variety of feelings, many of them disagreeable; and, if for any reason her attention becomes engaged with them, it is apt to become absorbed in their contemplation. If she has feelings along the back, she concludes she has spinal disease. If it is the head which disturbs her—and why should it not, with regular batteries of nerve-center explosions, touched off by her own untrained and rampant emotions?—she thinks there must be brain-disease or something horrible there; the more horrible in name the better it will suit the particular ebullition which names the disease."

Many interesting cases are given illustrating the illusions that thus arise; we quote a single one: "A young lady of seventeen came to me about ten years ago for what she and her friends supposed was disease of the hip-joint. After examination, I told her that there was no disease of the joint whatever. I tried to explain to her comprehension that, for some reason, she had become anxious about the hip-joint, and that her attention was so fixed on it that all sensations transmitted from that vicinity caused such throbs of the nerve-centers that an ordinary sensation was converted into an extraordinary one, and the anxious attention which she directed to that part made her painfully conscious of what would otherwise be normal sensations and thus unnoticed. But I failed to impress her sufficiently to divert her attention from the part, and she continued to walk on crutches, in all, during eight years. At last she suddenly found that she was not lame. I had the pleasure of examining her about six months after she had ascertained that she was not lame, and I found a wholly unaffected joint, precisely as it was seven years previously when I first saw her."

Sufficient has been said to illustrate the principal points of Dr. Taylor's discourse.

The subject is clearly presented, and his views and conclusions are not only practical, but so important that they can not receive too much popular attention.

ANTISEPTIC SURGERY: THE PRINCIPLES, MODES OF APPLICATION, AND RESULTS OF THE LISTER DRESSING. By Dr. JUST LUCAS-CHAMPIONNIÈRE, Surgeon to the Hôpital Tenon. Translated and edited by FREDERIC HENRY GERRISH, A. M., M. D., Professor of Materia Medica and Therapeuties in Bowdoin College. Portland: Loring, Short & Hannon. 1881. Pp. 240. Price, $2.25.

THE editor's object in introducing this work is to enable his fellow-practitioners in America, in the absence of any low-priced treatise on the subject in the English language, to gain such a knowledge of Lister's method as will enable them to apply it with essential accuracy. The method has become thoroughly established in medical science, and is being rapidly adopted by intelligent practitioners in all countries. It is recognized in England, "reigns supreme" in Denmark, "has its enthusiasts" in Germany, "has gained a firm foothold" in France, and is represented among the surgeons in Austria, Switzerland, Holland, Russia, Italy, and America. "Nélaton," says the author, "was accustomed to say that the man who should discover the means of suppressing purulent infection deserved a statue of gold. If this view of Nélaton's was generally entertained, the statue would be raised to Professor Lister, for purulent infection has disappeared from the list of wound complications in the services in which his method is followed."

THE ORIGIN OF PRIMITIVE SUPERSTITIONS, AND THEIR DEVELOPMENT INTO THE WORSHIP OF SPIRITS, AND THE DOCTRINE OF SPIRITUAL AGENCY AMONG THE ABORIGINES OF AMERICA. By RUSHTON M. DORMAN. Twenty-six Illustrations. Philadelphia: J. B. Lippincott & Co. 1881. Pp. 398. Price, $3.

MYTHOLOGY, as considered by the author, includes in its broadest definition all pagan religious beliefs, commonly called superstitions, and can not be confined to collections of fables and traditions, which are the folk-lore of peoples. In this, its larger sense, it is a very important branch of archæological science, and its study reflects much light into a past which written history has not penetrated. The author is struck with the universality of mythology, and with the evidence it presents of the homogeneity of man's religious beliefs, and his purpose is to collate the facts that show this homogeneity, to reduce to a system of religious beliefs the multitude of superstitions that have germinated among uncultured peoples, and to trace all superstitions to a common origin. The general prevalence of the same superstitions and folk-stories among primitive peoples has led to exaggerated efforts to trace a derivation of one system of mythological belief from another by contact or migration of myths. Mr. Dorman believes that these efforts have been wrongly directed; that the mythologies in question are all of natural development among each people; and that their similarities among all peoples in the same successive stages are explained by the fact that their growth has always and everywhere taken place according to the laws of man's spiritual being. Hence we have no need to assume communications between the negroes and the American Indians and other uncultured peoples, of the existence of which we have no evidence, to account for the coincidence of such myths as the "Uncle Remus" stories of the plantation negroes with similar stories among tribes strange to them. Mr. Dorman takes issue with those who believe that the higher phases of belief and worship have been the most ancient, and have become debased in the ruder forms. According to his view, "all primitive religious belief is polytheistic. All savage tribes are full of the terror of invisible spirits which have been liberated by death," which fill all nature, animate and inanimate, are in the air, the wind, the storm, the rock, the vale, the river, the water-fall, and which "transmigrate into human beings, animals, plants, and even into inanimate stones, idols, and heavenly bodies, which are supposed to be animate thereafter. Hence originates the worship of ancestors, and also of animals, plants, stones, idols, and the heavenly bodies." He is also convinced that those writers are wrong who have affirmed of any people that they are destitute of religious feeling, and as-

serts that many such authors have contradicted themselves unwittingly by giving lists of the superstitions of the people against whom they made the charge. In all his own studies on the subject he has not found a people, "no matter how savage, who have no religion, if the word is used in its broadest sense, to embrace all superstitions." He also denies that any of our Indians were primarily monotheists, or that the belief in a Supreme Being has existed among them for any considerable time, and asserts that no approach to monotheism had been made before the discovery of America by Europeans, and that the idea of the Great Spirit mentioned in books on the aboriginal tribes of America is an introduction by Christianity. The body of the work consists of citations from a host of authors illustrative of the condition of Indian thought and development in respect to religion, and especially in regard to the doctrine of spirits, fetichistic superstitions, rites, and ceremonies connected with the dead, animal-worship, the worship of trees and plants, of remarkable natural objects, and of the heavenly bodies, the animistic theory of meteorology, and priestcraft. The whole is as interesting as it is instructive, and as instructive as it is interesting, and is believed by Mr. Dorman to show that a gradual development from the rudest superstition, rather than a degeneracy from monotheism, has taken place; and that "the religion of the aboriginal tribes of America was a system of superstitions, all of which are explicable by the doctrine of the agency of multitudes of spirits, and in no other way."

Tokio Daigaku (University of Tokio). The Calendar of the Departments of Law, Science, and Literature. 2540 to 2541 (1880 to 1881). Tokio, Japan: Published by the University. Pp. (in English) 199.

Attention is first drawn to the historical summary which immediately follows the list of officers and professors, and relates the different steps in the organization and development of the university in detail. It shows that the introduction of Western learning into Japan dates from between 1703 and 1711; that an observatory was established in 1744; that a translation-office was instituted in 1811 to translate Dutch books; that the Dutch language was taught in 1858, and the English, French, German, and Russian languages were introduced, and courses in mathematics, botany, and chemistry were established in and after 1858; and that instruction was given mainly in the English language in 1867. The subsequent course of the university has been in the direction of expansive development, and need not be reviewed minutely. Instruction is given in the departments of law, science, and literature, which names cover nearly all that is included in similar departments in Western institutions, and some other matters peculiarly Japanese and Chinese, by American and European and Japanese professors. The law department includes English and French law, and ancient and present Japanese law; the scientific department is comprehensive; the literary department includes English literature, philosophy, political philosophy and economy, history, Buddhism, and Japanese and Chinese literature. More than fifty professors, assistants, and teachers are employed, two hundred and five students and ninety-two graduates are registered, and fifteen students are entered as sent abroad to England, France, and Germany.

English Philosophers: Bacon. By Thomas Fowler, M. A., F. S. A., Professor of Logic in the University of Oxford. New York: G. P. Putnam's Sons. 1881. Pp. 202. Price, $1.25.

Professor Fowler's object is, to present the character of the revolution which Bacon endeavored to effect in scientific method, as well as the nature of his philosophical opinions generally, in a form intelligible and interesting to readers who have no technical acquaintance with logic or philosophy. The several chapters include the life of Bacon, an account of his works, reviews of his "Survey of the Sciences," and his "Reform of Scientific Method," an examination of his philosophical and religious opinions, and an estimation of his influence on philosophy and science. On the last point, Professor Fowler believes that the influence and direction given by Bacon to science were of "the very highest importance." He called men to study the ways and imitate the processes of nature,

insisted on the importance of experiment as well as of observation, recalled men to the study of facts, promoted their emancipation from the bonds of authority and the enchantments of imagination, insisted on the subordination of scientific inquiries to practical aims, promoted hopefulness, and clothed his thoughts in marvelous language.

ELEMENTS OF GEOMETRY. By SIMON NEWCOMB, Professor of Mathematics, U. S. Navy. New York: Henry Holt & Co. 1881. Pp. 399. Price, $1.75.

PROFESSOR NEWCOMB does not, like many who have written on this subject, consider Euclid's system perfect, but believes that it fails in several points to meet modern requirements, and needs remodeling. This he attempts in a few features, most noticeably in the recognition of angles of a larger measurement than 180°. He accordingly treats the sum of two right angles as itself an angle, to which he gives the name of a "straight angle," and explicitly defines it. He also uses language more in accordance with modern ideas in speaking of planes. In an introductory book, besides the usual fundamental axioms and definitions, practical exercises are given in the practice of the analysis of geometric relations by means of the eye. Some of the first principles of conic sections have been developed, as a preliminary study of that subject, or to give some knowledge of those curves to those who do not intend to study analytical geometry. In proportion, a middle course has been adopted between the rigorous and prolix treatment of Euclid and the easier and simpler, but ungeometrical, method of American works.

DOCUMENTS RELATING TO THE HISTORY AND SETTLEMENTS OF THE TOWNS ALONG THE HUDSON AND MOHAWK RIVERS (WITH THE EXCEPTION OF ALBANY), FROM 1630 TO 1684. By B. FERNOW, Keeper of the "Historical Records." Albany, New York: Weed, Parsons & Co. Pp. 617.

THIS is the thirteenth volume of the series of documents relating to the colonial history of the State of New York, published officially under the direction of the Secretary of State. It embraces deeds, bargains, transactions of councils, memoirs, and correspondence, the general bearing of which illustrates the relations of the early settlers with the Indians. An important lesson drawn from these relations and their workings is that of the practical value of fair dealing with the Indians. It was the rule of the settlement of New Netherland, invariably enforced from the beginning, that no man could settle upon Indian land unless the Indian title was first extinguished in a manner satisfactory to the Indian proprietors. The consequence of the observance of the rule was that "the Dutch, living at the door of the powerful Five Nations, could always count upon the friendship of their Indian neighbors." This friendship had a momentous bearing upon the future of the continent, for it kept the Hudson River, the only natural route to the North and West, always open and safe for the white man, and thus greatly facilitated settlement.

HOUSES AND HOUSE-LIFE OF THE AMERICAN ABORIGINES. By LEWIS H. MORGAN. Washington: Government Printing-Office. Pp. 281, with numerous Plates.

THIS, the last work of the lamented author, was completed by him during the later days of his failing strength for publication in Major Powell's reports of the Geographical and Geological Survey of the Rocky Mountain region. It formed substantially the fifth part of the original manuscript of the author's "Ancient Society," but was omitted from that work on account of the size which it had reached. Parts of it have appeared in detached articles; a summary of the whole as a cyclopædia article; the substance of two of the chapters, as "Montezuma's Dinner" and the "Houses of the Mound-Builders," in the "North American Review"; and other parts, as "A Study of the Houses and House-Life of the Indian Tribes," with a scheme for exploring the ruins in New Mexico, Arizona, the San Juan region, Yucatan, and Central America, in the "Transactions of the Archæological Institute of America." The facts and views embodied in these articles being placed now in their proper connection, with others bearing upon the same point, the full force and clearness which they are capable of furnishing are given to the author's theory. That theory is that the

communal houses of the Indians at the time of the first white settlements in our country, the pueblos of New Mexico and Arizona, the structures whose ruins abound in Mexico and Central America, and the mounds of the mound-builders, illustrate a common type of house-construction and a communistic mode of living by the *gens* or tribe, which are not peculiar to the American aborigines, but have appeared as elements in primitive life at a stage between savagery and barbarism, among many other nations. The illustrations, drawn from and applied to all the classes of structures under review, and the historical citations, afford strong re-enforcements to the author's presentation.

GEOLOGY OF THE ENVIRONS OF TOKIO. By DAVID BRAUNS, Ph. D., M. D., Professor of Geology in Tokio Daigaku. Tokio, Japan: Tokio Daigaku. 1881. Pp. 85, with Eight Plates.

THIS is Number IV of the "Memoirs" of the Science Department of the University of Tokio, and contains accounts of the examinations of the alluvial, diluvial, and tertiary deposits of the neighborhood of Tokio, Yokohama, and other parts of Japan, some of which present difficult problems, and descriptions of the fossils (mollusks). The conclusion is reached that the Japanese shell-layers which were examined have the greatest resemblance with the Crag, and next to it with the younger sub-Apennine deposits, while the rocks resemble very closely the European Faluns. The plates, besides a sketch-map of the environs of Tokio, give representations of earth-sections and of some thirty typical fossils.

REPORT ON THE GEOLOGY AND RESOURCES OF THE BLACK HILLS OF DAKOTA. By HENRY NEWTON, E. M., and WALTER P. JENNEY, E. M. Washington: Government Printing-Office. Pp. 566, with Atlas.

PROFESSOR NEWTON'S part of this work includes the general introduction, observations on the routes to and from the Black Hills, and the account of the geological formations of the region, as observed in his survey during the summer of 1875. The author died in 1877, before completing his report, and the work of finishing it fell to Mr. C. K. Gilbert, who has performed it with fidelity to the author's intention, bearing in mind what has been learned concerning the gold of the Black Hills since the survey was made. Mr. Jenney's part of the report is his own exclusively, and includes a detailed review of the mineral resources, and the climate and general resources, of the Black Hills. Additional chapters, with plates of illustrations, are furnished: On "Paleontology," by R. P. Whitfield; "Microscopic Petrography," by John H. Caswell; "Botany," by Asa Gray; and "Astronomy" and "Barometric Hypsometry," by Horace F. Tuttle.

MEASUREMENTS OF THE FORCE OF GRAVITY AT TOKIO AND ON THE SUMMIT OF FUJINOYAMA. By T. C. MENDENHALL, Ph. D., Professor of Experimental Physics in Tokio Daigaku. Tokio, Japan: Published by Tokio Daigaku. 1881. Pp. 17.

THIS is Number V of the "Memoirs" of the Science Department of the University of Tokio. The experiments were conducted with a pendulum, in 1880, and produced results that seemed to show that the mountain is deficient in attraction.

PUBLICATIONS RECEIVED.

Chemical and Physical Analysis of Condensed Milk and Infants' Milk-Foods. By Dr. Nicholas Gerber. Translated and edited by Dr. H. Endemann. New York. 1882. Pp. 101. Nineteen Plates.

The Establishment of an International Tribunal. By A. H. Stoiber. New York. 1882. Pp. 24.

Catalogue of Southwick & Jenck's Natural History Goods. Providence, Rhode Island. 1881. Pp. 23.

Quarterly Report of the Chief of the Bureau of Statistics for the Three Months ended September 30, 1881. Washington: Government Printing-Office. 1882. Pp. 130.

Circulars of Information of the Bureau of Education. No. 5. 1881. Washington: Government Printing-Office. 1881. Pp. 47.

Pulpit Talks on Topics of the Time. By the Rev. J. H. Rylance, D. D. New York: I. K. Funk & Co. 1882. Pp. 46.

Question-Book of Natural Philosophy. With Notes, etc. By Albert P. Southwick. Ansonia, Ohio. 1881. Pp. 16. 10 cents.

Transactions of the New York Academy of Sciences, 1881–1882. Vol. i, No. 2. November, 1881. Published for the Academy. Pp. 29.

Contributions to the History of the Vertebrata of the Lower Eocene of Wyoming and New Mexico. Made during 1881. By E. D. Cope. Philadelphia, 1881. Pp. 98.

Report of the Proceedings of the Ensilage Congress. Published by the New York Plow Company. 1882. Illustrated. Pp. 66. 30 cents.

The Development History of the Flowers of the Gunnera Chilensis. By William A. Keller-

manu. Oshkosh, Wisconsin. 1881. Illustrated. Pp. 23.

The Chemical Cause of Life Theoretically and Experimentally Demonstrated. By Oscar Loew and Thomas Bokorny. Munich. 1881. Illustrated. Pp. 60.

Proceedings of the Boston Society of Natural History. Vol. xx, Part IV, January to April, 1880; and vol. xxi, Part I, May to December, 1880. Boston. 1880.

Scientific Proceedings of the Ohio Mechanics' Institute. Vol. i, No. 1. Cincinnati, January, 1882. Pp. 48. Quarterly, $1 a year.

Gold-bearing Drift of Indiana. By George Sutton, M. D. Reprinted from the "Proceedings of the A. A. A. S." Salem, Massachusetts. 1882.

Publications of the Cincinnati Observatory. Micrometrical Measurements of Four Hundred and Fifty-five Double Stars observed with the Eleven-Inch Refractor during the Year ending September 1, 1880, under the Direction of Ormond Stone, A. M., Astronomer. Cincinnati. 1882. Pp. 69.

Ninety-sixth Annual Report of the Society of Mechanics and Tradesmen of the City of New York. Prepared by the Finance Committee. New York: Henry Bessey, printer. 1882.

On the Effect of Prolonged Stress upon the Strength and Elasticity of Pine Timber. By R. H. Thurston. Reprint from the "Proceedings of the Cincinnati Meeting of the A. A. A. S." Pp. 8.

Boston Society of Natural History. Guides for Science Teaching. No. I. About Pebbles. By Alpheus Hyatt. 1879. Pp. 26. No. II. Concerning a Few Common Plants. By George L. Goodale. 1881. Pp. 61. No. III. Commercial and other Sponges. By Alpheus Hyatt. Illustrated. 1879. Pp. 43. No IV. A First Lesson in Natural History. By Mrs. Agassiz. Illustrated. 1879. Pp. 64. No. V. Common Hydroids, Corals, and Echinoderms. By Alpheus Hyatt. Illustrated. 1881. Pp. 32. No VI. The Oyster, Clam, and other Common Mollusks. By Alpheus Hyatt. Illustrated. 1881. Pp. 65. No. XII. Common Minerals and Rocks. By William C. Crosby. 1881. Pp. 130. Boston: Ginn, Heath & Co.

Annual Reports of the Boston Society of Natural History, 1879-1880; 1880-1881. Boston. 1882. Pp. 35.

Fifth Annual Report of the Superintendent of the Yellowstone National Park. By P. W. Norris. Washington: Government Printing-Office. 1882. Pp. 81. With Map.

Soluble Compressed Pellets. A New Form of Remedies for Hypodermic Use. By H. Augustus Wilson, M. D. Reprint from "Transactions of the American Medical Association," 1881. Philadelphia. 1881. Pp. 4.

Science in Public Schools. By George Davidson. Reprint from "Mining and Scientific Press." Pp. 5.

The Distribution of Plant Life. By Dr. B. W. Barton. Address before the Maryland Horticultural Society, April, 1881. Pp. 8.

Report on Diphtheria. By Franklin Staples, M. D. Winona, Minnesota. Pp. 44.

The Oyster Industry, by Ernest Engersoll, illustrated, 1881, pp. 250, and A Monograph on the Seal Islands of Alaska, by Henry W. Elliott, illustrated, 1882, pp. 176. Washington: Government Printing-Office.

Trance and Muscle Reading. By G. M. Beard, M. D. New York. 1882. Pp. 40.

Incandescent Electric Lights. New York: D. Van Nostrand. 1882. Pp. 176. 50 cents.

A Year of Miracle. A Poem in Four Sermons. By W. C. Gannett. Boston: George H. Ellis. 1882. Pp. 106. 50 cents.

Paine Genealogy, Ipswich Branch. By Albert W. Paine. Bangor, Maine. 1881. Pp. 184.

The Burgomaster's Wife. A Romance. By Georg Ebers. New York: William S. Gottsberger. 1882.

The Art of Voice Production. By A. A. Patton. New York: G. P. Putnam's Sons. 1882. Pp. 106. $1.

The Use of Tobacco. By J. L. D. Hinds, Ph. D. Cumberland Presbyterian Publishing House. 1882. 75 cents.

Marriage and Parentage. By a Physician and Sanitarian. New York: M. L. Holbrook & Co. 1882. Pp. 185.

The Temple Rebuilt. A Poem. By Frederick R. Abbe. Boston: D. Lothrop & Co. 1882. $1.25.

Beliefs about Man. By M. J. Savage. Boston: George H. Ellis. 1882. Pp. 130. $1.50.

The Gospel in the Stars, or Primeval Astronomy. By Joseph A. Seiss, D. D. Philadelphia: E. Clayton & Co. 1881. Pp. 452.

A Practical Treatise on Hernia. By Joseph H. Warren, M. D. Boston: J. R. Osgood & Co. 1882. Illustrated. Pp. 428. $5.

The Voyage of the Vega round Asia and Europe. By A. E. Nordenskiold. Translated by Alexander Leslie. New York: Macmillan & Co. 1882. Pp. 756. Illustrated. $6.

POPULAR MISCELLANY.

About Eggs.—All eggs of birds are good for food, and all are palatable enough to be eaten by a hungry man; but the most and the best food-eggs are furnished by the gallinaceous birds. The number of eggs consumed in the more populous countries is immense. Great Britain imports 785,000,000 from the Continent, they representing a value of more than £2,500,000; while Ireland furnishes nearly 500,000,000; and the home production is probably nearly equal to the amount of the importation from the Continent. The consumption, already so large, is increasing at a rate which shows that the value of this kind of food is steadily and rapidly growing in appreciation. The United States is supposed to produce 9,000,000,000 eggs annually, of which 25,500,000 dozen are sent to the New-York market. More than 800 dozen eggs are consumed in a single English hospital in the course of a year. The use of eggs as a standard article of diet has been limited by reason of their perishable nature; but this difficulty is now, in a measure, obviated by the desiccating and condensing process practiced in St. Louis and New York, and the canning process of Herr von Effner in Germany. Eggs are preserved in some parts of England by boiling them, removing the shells, and pickling them; in the United

States, by the common liming process, which keeps them fit for every purpose except that of boiling; and in China, by covering them with a paste of lime, salt, and ashes, from which they come out, however, rather the worse in appearance and smell. All eggs brought to Paris must be examined before being offered for sale; and sorted, by being passed through rings of three centimetres eight millimetres in diameter for the small, and four centimetres for the average size. An ordinary fowl's egg weighs from one and a half to two ounces; the egg of the duck from two to three ounces; those of the sea-gull and turkey from three to four ounces; that of the goose from four to six ounces. Eggs of wild birds are esteemed on account of the flavor that is given them by the food of the birds, and on account of the larger proportion of the more nutritious yellow that they contain. The ostrich is beginning to take rank as a valuable egg-producing domestic fowl. Each female bird will lay from twelve to sixteen, even, according to some, from twenty-five to thirty eggs, in August and September; and, as several couples will sometimes unite to hatch together, it often happens that as many as sixty eggs may be found in and around a single nest. Each of these eggs is considered equivalent to twenty-four eggs of the domestic hen; so that, as single domesticated birds have been said to lay eighty-two eggs in a season, we have the possible product of one ostrich represented by 2,624 hens' eggs. The eggs of the Australian emu, which are nearly as large as those of the ostrich, and green, are eaten by the settlers with much relish, although they are somewhat strong in flavor. The eggs of the Rhea ostrich of the South American pampas, of which forty, fifty, or seventy may be found in a nest, form a staple article of food during the spring months. The eggs of sea-fowl are largely consumed in many places, and those of the gull give rise to a considerable trade. A business of this kind is actively carried on off the coast of Northumberland, where prodigious quantities of eggs are collected; at the Pedro Keys, near Jamaica, where several kinds of sea and land birds resort; the coasts of Norway and Labrador; Funk Island, near Newfoundland; parts of the African coast, and islands generally. Eggs of water-fowl form an important part of the food of the Faroe Islands; the eggs of the dusky petrel are sent, in immense quantities, from Bass's Strait to Tasmania and Australia; incredible numbers of auks' eggs are collected on the coast of Labrador; the eggs of the malee-bird of Celebes are esteemed a great delicacy, and will each fill an ordinary tin cup, and form, with bread or rice, a very good meal.

The Yellows in the Peach-Tree.—Mr. W. K. Higley has given in the "American Naturalist" an account of the observations he has made to learn the cause of the yellows in the peach-tree and the manner in which it is disseminated. He is satisfied that the disease is due to a fungoid growth, but not to a *noemaspora*, as Mr. Taylor, of the Agricultural Department at Washington, believes, for that form occurs on other trees that receive no harm from its presence; nor to a fungus in the tissues of the roots, for no fungus has been recorded as occurring there. He worked, in his examinations, upon the theory that the fungus must be natural to the tree, enjoying the same conditions of development as are favorable to the growth of the tree. Hence, he took no pains to cultivate the plant, but examined specimens as they were gathered from diseased trees. Nothing was found in the roots. Mycelia were found in sections of the trunk, on the under side of the inner bark next to the cambium layer, with many of the filaments penetrating and ramifying through that layer, and, in some specimens, mycelia between the layers of wood. In some of the smaller branches and the growing ends of the larger branches, the tissues seemed to be completely filled with mycelia, and in one case the bark appeared to be split. Filaments of fungus were found in the leaves of the abnormal branches characteristic of trees affected with the yellows, and the chlorophyl in all such leaves was completely disorganized. The most satisfactory results were obtained from the examination of the fruits, in which mycelia were abundantly found just beneath the skin, extending for a short distance into the fleshy parenchyma. The form was the same as that which was found in other parts

of the tree; this form, Mr. Higley believes, as the final result of his investigations so far, to be at least a part of and probably the whole cause of the disease. The affection is, of course, transmitted by whatever will convey the fungus or its spores. Mr. Higley has no faith in any of the cures that have been proposed for the yellows, and believes that where they have seemed to be successful, not yellows, but some other cause of trouble was present. The only remedy he can propose is to root out the tree and burn every part.

The Approaching Transit of Venus.— An international conference respecting the observations of the transit of Venus, which will take place next December, was held in Paris last October, under the presidency of M. J. B. Dumas. Most of the European countries, Brazil, Chili, and the Argentine Republic, were represented, and reported upon the observing stations which would be cared for by their respective countries. France will establish eight stations, Brazil five, Germany four, Denmark and the Netherlands, Austria, Hungary, Chili, and Mexico one each, Spain and the Argentine Republic two each, forming a line of stations from the southern part of the United States through Central America, the West Indies, and the east and west coasts of South America to the Strait of Magellan. Besides these, Great Britain will have sixteen stations arranged in groups of two, with principal centers of observation at the Cape of Good Hope, in Australia, New Zealand, and the Antilles; and Portugal will have two stations within its proper limits, and one at Benguela or Lorenço Marquez. No reports were made from Italy and the United States. A committee to which the subject was referred made a report concerning the best arrangements for details of observation; and a resolution was adopted in favor of calling, after the return of the observing expeditions, an "International Commission on the Transits of Venus," in which each state should be represented by a plenipotentiary, to form a provisional organization for collecting all the data of the observations, and deducing from them in common a general determination of the parallax of the sun.

Sewage in Oysters. — The oysters of Dublin Bay are threatened with extinction in consequence of the turning of the sewage of the city into the water. Edible fish were numerous a generation ago in the river Liffey, which is the chief carrier of sewage to the bay, but now they are rarely seen there. Oysters were taken for examination, by Dr. Charles A. Cameron, from a spot which is covered by about ten feet of water at high tide, but is nearly dry at low water. The brine of a large proportion of them emitted a slight but distinctly fetid odor, and when examined microscopically was found to swarm with micrococci and other low organisms of sewage. Of samples of sea-water taken at the beds at high tide and from little pools containing oysters at low water, the latter contained ten times as much albuminoid ammonia and thirty times as much saline ammonia as the former, proving that it was in great part composed of sewage. It is impossible for the oysters to keep from imbibing much of this water; and if we sometimes acquire the germs of fever from drinking water and milk, why may we not also from the juice of oysters raised in sewage-polluted waters?

Malarial Organisms.—M. A. Laveran has found, in the blood of patients suffering from malarial poisoning, parasitic organisms, very definite in form and most remarkable in character; motionless, cylindrical curved bodies, transparent and of delicate outlines, curved at the extremities; transparent spherical forms provided with fine filaments in rapid movement, which he believes to be animalcules; and spherical or irregular bodies, which appeared to be the "cadaveric" stage of these, all marked with pigment-granules. He has also detected peculiar conditions in the blood itself. During the year that has passed since he first discovered these elements, M. Laveran has examined the blood in one hundred and ninety-two patients affected with various symptoms of malarial disease, and has found the organisms in one hundred and eighty of them, and he has convinced himself by numerous and repeated observations that they are not found in the blood of persons suffering from diseases that are not of malarial origin. In general, the

parasitic bodies were found in the blood only at certain times, a little before and at the moment of the accession of the fever; and they rapidly disappeared under the influence of a quinine treatment. The addition of a minute quantity of a dilute solution of sulphate of quinine to a drop of blood sufficed to destroy the organisms. Mr. Laveran believes that the absence of the organisms in most of the cases (only twelve in the whole one hundred and ninety-two) in which he failed to find them was due to the patients having undergone a course of treatment with quinine.

The Freezing of a Salt Lake.—Dr. Woeikoff has published the results of some observations which were made at his suggestion into the conditions of freezing and thawing of a salt lake near Orenburg, Russia. The lake has a surface of 473 square metres and is about five feet deep. Its water contains sixteen per cent of salt, and the mud of its bottom is rich in sulphuretted hydrogen. During January, 1879, except for one day, when the temperature was barely above the freezing-point, the thermometer in the air ranged from −6·3° to −28·2° centigrade, while the temperature of the water at the surface was from −3·4° to −13° C., and at the bottom from −3·8° to −12·8° C. On the 27th of December, when the temperature of the air was as low as −21° C., the lake was covered with a viscous ice, which soon began to thaw, however, when the temperature of the air rose to −6° C., and the temperature of the water was as low as −7·8° C. By the 3d of January all the ice had disappeared, but the temperature of the water was still 7·2° C. below the freezing-point, or about 19° Fahr. On January 11th, the temperature of the air being −22° C., and that of the water being −9·8° C. at the surface and −5·6° at the bottom, the lake began again to be covered with viscous ice, and soon froze, the ice reaching a thickness of about six inches in ten days. But the remainder of the water was still unfrozen, notwithstanding that its temperature decreased to −10° C. on January 17th, and even to −12·8° C. on January 30th. Never before, says Dr. Woeikoff, were temperatures below −4° C. or 24·8° Fahr. observed in saline solutions outside of laboratories, while here were temperatures of −13° C., or 8·6° Fahr., observed in a salt lake. However, former experiments, especially those of M. Zöppritz, have proved that there is no diffusion of salt before congelation; it seems that in this lake (Kupalnoze) there is such a diffusion of salt toward the lower stratum of water, even before the freezing begins, otherwise it would be difficult to explain how colder water might remain on the surface, were it not for the greater amount of salt in the lower strata. It has always been difficult to explain how ice is formed on the surface of oceans while the temperature of maximum density is lower than that of congelation, and the observations on this lake were instituted in the hope that they might throw light upon the subject. The lake, however, contains too much salt to afford a sure standard of comparison with oceanic water.

A Collection of Quaint Scientific Instruments.—The Royal Mathematical and Physical Museum, in Dresden, Saxony, was founded by Prince Augustus I in the sixteenth century, and has grown into an extensive collection of articles illustrating the condition of science at particular periods, and its progress. "According to Adam Ries," a German expression to denote that any fact is mathematically exact, refers to the mathematician, Adam Ries, who in 1550 published a little book on reckoning with counters and with the Arabic numerals. His counters, and the hand-circles, staffs, and various devices with which people made their calculations before the Arabic numerals came into general use, are shown here. Another curious instrument, of the eighteenth century, is a proportion staff "for the mechanical extraction of the square and cube roots, and the proportioning and calculation of geometrical figures." Among the optical instruments is the famous burning mirror of Walter von Tschirnhausen, of which the "Acta Erudita" from 1687 to 1697 says, "He has with this glass set fire to wet wood in an instant, boiled water in a small vessel, melted lead, bored through iron plates, changed brick and stone to glass." Tschirnhausen performed the first experiments on solubility of the earths with this instrument.

The collection of clocks comprises nearly every conceivable variety of time-pieces, from sand-clocks to the Dresden Universal Clock which gave the time at three hundred and sixty places, and automatons driven by clock-work. The collection of telescopes covers nearly the whole history of the instrument, beginning with a Galileo's telescope and including a Kepler's, a Rheita's, the Huygens's, Dolland's, and Frauenhofer's refractors, and several kinds of reflectors. One of the most precious articles in the collection is a very elaborate globe, with all the principal constellations and astronomical lines, and the magnitudes of the stars carefully indicated, which bears an inscription stating that it was made by Mohammed Ben Muwajed-el-Ardhi, without date or place of making. Beigel, of Dresden, calculated in 1808, from the positions of some of the stars on the globe, that it must have been made in the ninth century. Dr. Adolph Drechsler believes that the maker was a son of the famous astronomer Muwajed, who was called by Hulagu, the third emperor of the Mogul dynasty, from Damascus to superintend the observatory at Maragha, and that the date of the instrument was about A. D. 1279. The chief value of the collection is in the opportunities it affords for the study of the development of instruments in the several branches of science.

Evolution of Deer-Horns. — Mr. W. Boyd Dawkins has called attention to the confirmation of the doctrine of evolution afforded by the development of the antlers of animals of the deer-kind. In the middle stage of the Miocene, the cervine antler consists merely of a forked crown. This increases in size in the Upper Miocene, though it still remains small and erect, being not quite eleven and a half inches long, with four small tines in *Cervus Matheri*. The antlers of the succeeding (Pliocene) deer, in the Auvergne, were longer and larger and more branching than those of any earlier deer, and had three or more well-developed tines. The *Cervus dicranios* of the Upper Pliocene of the Val d'Arno had antlers so complicated as almost to defy description, though they were still smaller than those of the Irish elk. That animal survived into the succeeding age, and has been described in England as Sedgwick's deer. The Irish elk, moose, stag, reindeer, and fallow deer, appeared in Europe in the Pleistocene age, all with highly complicated antlers in the adult, the first having the largest antlers as yet known. "From this survey," says Mr. Dawkins, "it is obvious that the cervine antlers have increased in size and complexity from the mid-Miocene to the Pleistocene age, and that their successive changes have been analogous to those that are observed in the antlers of the living deer, which begin with a simple point and increase in number of tines till their limit of growth is reached. In other words, the development of antlers indicated at successive and widely separated pages of the geological record is the same as that observed in the history of a single living species."

Tests for Color-Blindness.—Dr. William Thomson, of Jefferson Medical College, has devised a test for color-blindness, for use on the Pennsylvania Railroad, which is in a measure self-working, and may be applied with precision by any agent at any station on the line. It is based on Holmgren's system of many-colored yarns, but the number of skeins is reduced from the one hundred and fifty used by Holmgren to forty. The forty skeins, each bearing its serial number, are hung by buttons, that can be easily unhooked, upon a stick about two feet long, in such a way that the numbers are hid. The first half of the series of yarns, numbered from one to twenty, are devoted to the green test. The odd-numbered skeins are of shades of green, and the even-numbered ones of "confusion colors"—grays, tans, light browns, etc. The other half is similarly occupied with skeins of red, and the "confusion colors" for red-browns, sages, and dark olive, arranged alternately. A man placed before the instrument is told to select ten skeins to match the green test-skein, which is shown him. If his eyes are normal, he will readily select the ten green skeins, and the clerk simply finds the numbers of the skeins thus selected and puts them down. If the man's eyes are defective, he will hesitate in selecting the skeins; if color-blind, he will throw out skeins at

random of the green and confusion colors. In either case the clerk has only to set down the numbers, which tell the story, and furnish the medical man all the facts he needs for making up his judgment. The test is applied in precisely the same way by means of the other half of the stick for red-blindness. The reports of the examinations have almost uniformly shown that 4·2 per cent of the men are color-blind.

New Conditions affecting Life in France.—M. A. Legoyt has continued his reviews of the movement of population in France, with a study of the vital statistics of the nation for 1879. The population of the country continues to increase, but at a constantly diminishing rate. The hygienic condition of the people has been improved by the prevalence of greater ease in living, the spread of vaccination, and increased scientific exactness in the healing art; but new causes of mortality, incontestably grave, have been introduced. The chief of these is the excessive use of alcoholic drinks, signalized by the more general consumption of liquors distilled from grain and the beet-root, taking the place of wine, which is likely to increase if the ravages of the phylloxera continue. It is also marked by an increase of arrests for intoxication, of persons found dead, and of suicides, traceable to this cause. The number of suicides has almost quadrupled since 1827, while the population has increased only one-fifth. The growth of mental diseases is also detrimental to public health and longevity. A new cause of mortality worthy of attention is the continued increase in the prices of the necessaries of life, accompanied by a decrease in the rate of interest on invested funds. The population decreased in 1879 in twenty-six departments, most of which were in Southern France, where distress was occasioned by the ravages of the phylloxera. In details, the vital reports for 1879 show a slight increase of marriages, a few less births, a few more deaths, than were returned in 1878, and a decrease in the excess of births over deaths, which was already small enough. No direct regular relation is discoverable, either in France or in twelve other countries which are compared with it for this view, between the proportion, to the thousand, of marriages, births, and deaths. Generally, but not always, a greater number of marriages was followed by a greater number of births.

Theories of Comets' Tails.—M. Camille Flammarion suggested an inquiry at a recent session of the French Academy of Sciences, whether the perfect transparency of the tails of comets should not authorize us to believe that they are not material, but an electrical or other excitation of the ether produced by the mysterious star in a direction opposite to that of the sun. M. Faye at a subsequent sitting answered this suggestion with a material theory, to the effect that the sun appears to be endowed at the same time with two forms of action, one attractive, the other repulsive. The repulsive force is not proportional to the masses, like attraction, but to the surfaces, and therefore produces effects which are more marked as the matters on which it acts are less dense. It is not exercised through every kind of matter, like attraction, but may be enfeebled or arrested by the interposition of the slightest screen. It is not propagated instantaneously, as attraction is, but successively, like light and heat; hence its action upon a point in motion is not exercised in the same direction as attraction, although both forces emanate from the same star. Finally, this force varies inversely as the square of the distance, the same as light and heat. The repulsive force operates on the planets and their satellites as well as upon comets, but has escaped attention as to them, in consequence of their compactness. It operates also upon our globe, upon the limits of our atmosphere, but its meteorological effects are masked by the more evident effects of solar radiation which are at work during exactly the same period. Multiple tails to comets are not exceptional, as was till lately believed; that quality has been found to be more general as comets have been observed with more powerful instruments. The recent comet (*b*, 1881), it is true, seems to have but one tail; but that is because we are not far removed from the plane of its orbit, within which all the tails are included, so that they appear to us projected upon one another. For the same reason the tail of this comet appears straight.

If we looked at it from the front instead of in section, its natural curvature would strike every eye. M. Flammarion upheld his electrical theory at the succeeding meeting of the Academy, maintaining that no solution of continuity had ever been remarked upon any comet. The tail has always appeared homogeneous, plane, still, like a beam of electric light. He acknowledged that his interpretation was hypothetical, but claimed that his hypothesis was very probable. Might not the electrical illumination, he said, very intense in the nucleus, more feeble in the immediate surrounding, be prolonged into space, impelled by the contrary electrization of the sun? The phenomena of those long, imponderable, and transparent tails, hitherto unexplained, would then be a simple luminous excitation of the ether.

New Carboniferous Fossils.—A considerable addition to the fauna of the Lower Carboniferous period has been made by the recent discovery in the shales of Eskdale and Liddesdale on the river Esk, in Scotland, of the fossils of a larger number of new organisms than have been obtained from the entire Carboniferous system of Scotland for years past. The remains are in an excel lent state of preservation, and in some instances are so admirably wrapped up in thin matrices as to retain structures which have never before been recognized in a fossil state. Among them are twenty new species, adding to science five new genera, of ganoid fishes. One of the genera, *Tarrasius*, is so peculiar that no place can be found for it in any known famliy. Two specimens have been found in such conditions as to leave in doubt some important parts of their structure. Associated with the skeletons of the fishes are some new phyllopod and decapod crustaceans, one of them having its intestinal canal distended with food. Several new macrurous decapods occur that differ in no essential respect from their living representatives. Numerous and often admirably preserved specimens of scorpions have been found, of forms that do not differ essentially, so far as regards external organs, from the living scorpion. Mr. Peach, who describes them, has recognized in them every structure of the recent form, down even to hairs and hooks on the feet. The sting alone has not been observed, but the poison-gland has been found. The chief difference lies in the larger proportion of their mesial eyes to the lateral ones, and to the whole animal, than in the living form. These fossils afford no more help in tracing the pedigree of the scorpion than is furnished by the living form, for they make it obvious that the animal has remained with hardly any change since Carboniferous times. It appears to be the most ancient type of arachnid. Some species must have included individuals eight or ten inches in length.

Animal Retribution.—The Boston papers tell a curious story of the retribution which recently came upon a buck, which, by virtue of his superior strength and sagacity, had exercised a tyrannous lordship over the herd of deer on the Common, and had thereby excited the hatred of the younger bucks. The time came when he had to shed his horns. The other bucks gained knowledge of the fact with a marvelous quickness, gathered around him, made a concerted attack upon him and speedily disabled him, despite the gallant resistance he tried to make. He was knocked down, butted and kicked till his head and sides streamed with blood, shoved this way and that, with all the fury accompanying each action that the pent-up spite of years could render itself capable of, and, finally, was reluctantly compelled to give up the ghost. Several of the men employed on the Common and public grounds witnessed the affray, and attempts were made to drive off the old fellow's assailants, but it was of no use. Each attempt was resented by the infuriated deer, and every man who entered the inclosure with pacific intentions was obliged to flee for his life. The murder having been consummated, the fury of the animals became appeased, and the dead carcass was removed from the arena.

Permanence of Vegetable Structures.—Dr. Karl Müller has recently observed a very noteworthy instance of the permanence of vegetable tissues in the case of specimens of mosses that were taken from the ancient viking ship which we described in our May number as having been found last year on the coast of Norway. The mosses had

been buried with the vessel for about a thousand years, yet they retained their structure unimpaired, only they had become browned, or turned to brown-coal, and were easily identified as belonging to *Hypnum squarrosum*, *Climacium dendroides*, and other common species. No difficulty was met in making a satisfactory microscopical examination of them, and the cell-structure was brought out as plainly as if they had been freshly gathered. These, however, were only some of the more recent among several ancient specimens of peat-mosses that Dr. Müller reports that he has examined with similar results. The mosses of a tuft supposed to be from the lake-dwellings retained the individuality of their parts; and in a tuft taken from the turf under the drift in the Baltic provinces of Prussia, the plants, older by hundreds of thousands of years than the other specimens, were so well preserved that they were easily recognized by their form and cell-structure as belonging to a Scandinavian species of almost exclusively Arctic growth, which must have come down in the glacial period. We are often surprised at the good condition in which the unfossilized bones of prehistoric men and animals are sometimes found; but the beautifully preserved condition in which these mosses occur is a far more wonderful phenomenon, because those organisms are among the plants of the slightest structure, and are not subject to fossilization. Still more wonderful is the perfection with which the minute structure of the diatoms is preserved.

Soldering by Pressure.—It is known that Faraday, in 1850, observed that two pieces of ice brought in contact and subjected to pressure would be soldered together, and unite into a homogeneous mass. This soldering, which took place the more readily in proportion as the pieces of ice were nearer their melting-point, was regarded by Faraday as due to a special property of ice. Mr. W. Spring has recently undertaken a methodical series of experiments in the compression of a variety of bodies. That their condition of division might be well established, he reduced the substances experimented upon to powder, and subjected them in a mold of steel to a pressure of between two thousand and seven thousand atmospheres. Filings of lead were converted at two thousand atmospheres into a solid block, showing no granulation under the microscope, with a density slightly above that of ordinary lead. At five thousand atmospheres the lead became like a liquid, and ran into all the interstices of the apparatus. Powders of zinc and bismuth at five to six thousand atmospheres gave solid blocks, with a crystalline fracture. Approaching six thousand atmospheres, zinc and tin seemed to liquefy. Powder of prismatic sulphur was converted into a solid block of octahedric sulphur. Slack sulphur and octahedric sulphur passed into the same condition. Red phosphorus passed into the denser state of black phosphorus. Thus, simple bodies undergo chemical transformations under the simple action of pressure. The transformation of amorphous powders, like that of zinc, into crystalline masses, is a kind of auto-combination. Some of the hard metals never lose their pulverulent structure under any pressure. Powders of the bioxide of manganese and the sulphurets of zinc and lead solder under pressure, and present the aspect of natural crystalline pyrolusite, blende, and galena; while silica and the oxides and sulphurets of arsenic do not suffer any agglomeration. Some pulverized salts are solidified by pressure, and become transparent. Hydrated salts—as, for example, sulphate of soda—may be completely liquefied at a high pressure. Certain organic substances—the fatty acids, moist cotton, and starch—change their appearance, lose their texture, and undergo a very evident molecular packing.

NOTES.

The city of Charleston, South Carolina, according to the annual review of Mayor Courtenay, is paying a much higher relative rate for school purposes than Northern cities which have secured for themselves greater educational advantages. Compared with Boston, it gives, in proportion, nearly one half as much again for its primary public schools alone as that city for all its schools, and gives, besides, annual appropriations to the High School and Charleston College. The grievous burden has been thrown upon the city by the extraordinary needs of the colored population, and gives it, the city officers believe, a right to call upon the Government for help.

THE largest trees known are probably a *Eucalyptus amygdalina*, or "peppermint-tree," growing in the Dandenong district of Victoria, Australia, which is said to measure 370 feet to the starting-point of the crown, and 417 feet to the top, and a specimen of the same species, mentioned by Baron Ferdinand von Müller as having reached the incredible height of 480 feet. A tree was cut near Ballarat in 1869 which was 96 feet in circumference at the ground, 34 feet at 12 feet above the ground, 8 feet at the height of 144 feet, and at 210 feet was still five feet in circumference. Another tree measured three feet in circumference at the extreme point of its height, 385 feet, while its real top seemed to be missing.

THE death is announced of Theodor Schwann, the distinguished physiologist, whose name is inseparably connected with the history of the "cell theory." He was born in 1810 near Düsseldorf, but spent most of his active life as Professor of Anatomy in the Catholic Universities of Louvain and Liége, Belgium. Three important pieces of work, each of which has been the starting-point of endless researches, are due to him. The first consists in his observations and reflections relative to the cell-structure of organisms; the second, his discovery of the organic nature of yeast, of the yeast-plant as the cause of alcoholic fermentation, and of organisms as the cause of putrefaction in general; and the third, his investigation of the laws of muscular contraction.

DR. W. J. HOFFMAN observes, in his "Annotated List of the Birds of Nevada," that the absence of birds in large areas in that State, and their abundance in certain localities, "can mainly be attributed to the peculiar distribution of the vegetation. With the birds, as with insects, particularly the *Coleopteræ*, if an area of vegetation, composed of a certain class, be found, we generally know what may be expected as typical of that area. The greater altitudes attained in the Rocky Mountains have furnished additional facts regarding the breeding of certain species, which may truly be considered sub-Alpine when compared with their northward range."

THE statements in reference to the education estimates for England, made by Mr. Mundella, in the House of Commons, indicate that it is the intention of those having the matter in hand to make elementary education more efficient and better adapted to convey to the pupils a knowledge of those things that will be really useful to them in after-life. Among the amended provisions of the code laid before the House was one for giving in infant schools a systematic course of simple lessons on objects and on the phenomena of nature and common life. Among the "class-subjects" in boys' and girls' schools are physical geography and elementary science, and among the specific subjects are mechanics, animal physiology, botany, the principles of agriculture, and domestic economy.

DR. EDWARD T. CARSWELL, in his address as president before the American Academy of Medicine, takes strong grounds in favor of requiring evidence of graduation from a college as a condition of admission to the medical school, and of the abolition of the fee system, as essential elements of reform in medical education.

THE recent International Medical Congress in London recommended as tests for sight, to be enforced on signal-men and look-out men at sea, that in all ocean-going vessels there should always be in actual control of the helm a person possessing with both eyes, without glasses, normal sight both as to acuity and colors, and that in addition one of the persons on the look-out should be similarly qualified; that in vessels engaged in the coasting-trade, every person liable to take charge of the helm should possess sight under similar conditions, equal to at least two thirds of the normal; that all persons engaged in marine signaling and all pilots should have normal sight; and that hypermetropic (over-sighted) persons should not be admitted. The congress also advised the constitution of an international commission to consider the means of improving the system of signals, and to fix upon the standard colors and upon the sizes of the signals to be employed.

THE death of Dr. Christian Gottfried Andreas Giebel, Professor of Zoölogy in the University of Halle, was recently announced. He was born in 1820, and had occupied his professorate at Halle since 1860. He was the author of numerous works in his branch of science, among which were the "Fauna of the Primitive World" (1856), "The Mammalia in their Zoölogical, Anatomical, and Palæontological Relations" (1855), "A Natural History of the Animal Kingdom" (1864), "Agricultural Zoölogy" (1869), a "Thesaurus Ornithologiæ" (1877), and a work on "Parasitic Insects," besides numerous smaller works.

DR. J. BOUILLAUD, a French physician distinguished for his researches in heart disease, died in Paris last October, in the eighty-sixth year of his age. He discovered the relations between organic affections of the heart and acute articular rheumatism, and recognized and partially defined the anatomical lesion which produces aphasia. He published his first work, a "Treatise on Diseases of the Heart," in 1824.

Dr. D. W. Prentiss, of Washington, D. C., has described a remarkable change in the color of the hair which followed the use of pilocarpine in the case of a young woman treated by him. The hair, which was at first light blonde, with a yellow tinge, became chestnut brown in the course of a month and almost a pure black in six months, and acquired a more vigorous and thicker growth. A microscopic examination showed that the change in color was due to an increase of the normal pigment, and not to a dye. The eyes also became darker. The hair of an infant, treated for croup, showed a distinct change to a darker color after ten days' use of pilocarpine.

The death is announced of M. Bussy, the eminent French chemist. He was the first person that succeeded in obtaining metallic magnesium.

Mr. M. E. Wadsworth has called attention to a confusion in which the term Laurentian as the name of a geological formation has become involved by its having been appropriated to two different sets of rocks. Mr. Edward Desor first used the name in 1850, and applied it to some marine deposits in Maine, on the St. Lawrence River, and on Lakes Champlain and Ontario. He employed it afterward in several papers published in scientific journals and transactions, and it seems to have passed into current use among geologists between 1850 and 1857. Sir William Logan in 1854 applied the same name to the Canadian rocks, which he had heretofore called the "metamorphic series," and which are the equivalents of the Azoic rocks of Foster and Whitney. Mr. Wadsworth maintains that the later appropriation should give way to the earlier application.

Professor E. D. Cope describes the remains of a large mosasauroid reptile, to which he gives the name of *Clidastes conodon*, of which a part of a skeleton has been discovered by Professor Samuel Lockwood near Freehold, New Jersey. The parts found include numerous vertebræ; the greater part of the lower jaw, with some teeth; a humerus and ulna nearly perfect; a nearly entire coracoid, and parts of both scapulæ; and indicate an animal larger than any *Clidastes* hitherto known.

Hermann von Schlagintweit, the eldest of the three brothers who became distinguished by their explorations of the highlands and mountain-regions of India, died in Munich on the 19th of January. He was born in 1826, published works on the physical geography of the Alps in 1850 and 1854, and in the three years following 1844 traveled with his brothers Adolph and Robert through the East Himalaya region and Assam, Cashmere, Ladakh, and Balti, and over the Karakorum and Kuen-Lun Mountains to Chinese Turkistan. The results of their explorations have been embodied in two works of high scientific value, which, unfortunately, are not yet completed.

The crayon-pencils now much used by children have been found to be colored with poisonous dyes. The Dublin "Journal of Medicine" has an account of a child who was taken with all the symptoms of poisoning, for which he was treated with emetics and purgatives. The vomited matter was marked by particles of a green substance containing copper, and the discharges from the bowels bright-green fragments. The child was sick for a month. It was found, on examination, that he had eaten a part of a green crayon, colored with arsenite of copper.

The deaths of Dr. Karl Peters, Professor of Mineralogy and Geology at Grätz University, and author of numerous papers, and of Dr. Karl Fortlage, Professor of Philosophy at the University of Jena, are announced. Dr. Peters was fifty-seven and Dr. Fortlage seventy-five years of age.

A report has been published by the Legislative Assembly of New South Wales on museums for technology, science, and art, and upon scientific, professional, and technical instruction in the colony, which is full of information in connection with the extension of scientific instruction in its relations to technology.

Dr. Pellegrino Manteucci, who died in London on the 8th of August last, in the thirty-first year of his age, had just accomplished the hitherto unachieved task of crossing Africa from the Red Sea to the Gulf of Guinea. He left Suakim on the Red Sea, with two companions, in March, 1880, with the intention of crossing the continent. Prince Borghese left him at Darfoor, and he and Lieutenant Massari went on alone. Reaching the Niger, they embarked on that river and arrived at Egga, where they found the agent of a European company on the 8th of June, and set sail for Europe on the 1st of July. The two travelers entered the Mersey on the 5th of August, only three days before Manteucci's death.

The first discovery of fossil human remains in the caverns of Brazil has been made by Dr. Lund near Agua Santa, province of Minas Geraes, where an osseous *breccia* has been found, containing human *débris*, closely associated with the remains of extinct species.

Dr. Javal has recently declared, in a communication to the Société de Médecine Publique et d'Hygiène Professionelle, that the electric light, in the degree of division to which it has been brought, is absolutely harmless, and without danger to the sight.

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